# ITS Cost Analysis

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### COST ANALYSIS DOCUMENT June 1996

### **EXECUTIVE SUMMARY**

The goal of the cost analysis of the ITS National Architecture program is twofold. First, the evaluation is to produce a high-level estimate of the expenditures associated with implementing the physical elements and the functional capabilities of ITS Services as these services are likely to be deployed utilizing the ITS National Architecture. The second goal of the cost evaluation is to provide a costing tool for ITS implementors.

The Cost Analysis document presents the estimate of expenditures for an Evaluatory Design implemented over three scenarios. One scenario includes a major urban area described as Urbansville. Additional scenarios are an inter-urban area, Thruville, and a rural area, Mountainville. The cost evaluations are based upon a detailed physical element categorization within each subsystem and an aggregation of total expenditures into initial investment (non-recurring) expenditures, as well as operation and maintenance (recurring) expenditures. Each scenario analysis covers a twenty-year deployment period.

The bases for cost analysis were the Subsystems and Equipment Packages defined by the Physical Architecture. The relationship between Market Packages (i.e. User Services) and Equipment Packages (i.e. physical deployment of ITS services) is detailed in Table 4.5.2-1. Using the quantities for Equipment Package Deployment (high and low by time frame and scenario) developed in the Evaluatory Design the expenditures for the three typical area-wide deployments, Urbansville, Thruville, and Mountainville were calculated. Some of the summary results of this effort are presented below. However, the expenditures for typical area-wide deployments have limited value to implementors outside of the order of magnitude estimate for fully deployed ITS services. A major emphasis for the Phase II evaluation, therefore, is to provide a costing methodology and ranges of unit prices for the various ITS services, rather than emphasizing a bottom line expenditure for the three scenarios. The Cost Analysis Document provides a detailed cost estimate for each Equipment Package in the architecture, and presents a methodology for the development of non-recurring and recurring costs on any configuration an implementor would define. As such, the actual document serves as a resource guide for costing activities.

Unit price ranges for Equipment Packages are based on available information for recently deployed ITS projects, as well as the justified unit prices developed during the architecture program by not only the Phase II teams, but by the other teams which participated in Phase I of the architecture program. In addition to providing a range of unit prices for equipment, a range of market penetration is incorporated into the analysis. The basis for the market penetration range is provided in the Evaluatory Design Document. The application of the high and low market penetrations are demonstrated through spreadsheet applications.

Any effort to create summary cost numbers is highly influenced by the assumptions made in the analysis. The Evaluatory Design contains many, but not all of the assumptions used in the analysis. It contains the definition of populations (of users) and the definition of the elements (and the number of each) that are contained in each Equipment Package. For

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example, the Network Surveillance Equipment Package (which is in the Roadway Subsystem) has a number of detector loops which is tied to the number of intersections and the penetration estimate (what percentage of intersections are instrumented).

In addition to the Evaluatory Design quantities, there are other assumptions which have a critical impact on the summary results. For example, are communication lines between the Roadway and the Traffic Management Subsystem owned by the public agency (and hence subject to initial capital installation costs), are they leased from a private communications provider, or are they paid for on a per use basis (again from a communications provider)? On this key decision the Cost Analysis has chosen to use leased lines for all of the wireline communications (i.e. fixed communications between centers). This has the impact of lowering significantly the non-recurring costs for the public infrastructure, and increasing the recurring costs. The architecture teams recognize that each locality will make its own decision on whether to install communications or purchase the needed lines.

Another assumption which impacts the cost summaries is which elements to include as part of each ITS functionality and which to not include. The architecture teams have tried to include all new hardware, software, building space, and personnel required to provide the functionality of the Equipment Packages. That is, neither existing vehicles (e.g. for incident management) nor existing functionality (e.g. call boxes) are included.

Scenario expenditures for Urbansville, Thruville, and Mountainville are classified into likely stakeholder responsibility for funding. The resulting allocations for each scenario are presented below.

### Urbansville High Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	12%
Commercial	7%
Individual	81%

# Thruville High Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total		
Stakeholder	Funding Requirements		
Government	13%		
Commercial	5%		
Individual	82%		

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### Mountainville High Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	36%
Commercial	18%
Individual	46%

The non-recurring expenditures for the government stakeholder group are tabulated below for the deployment year milestones. Note that the five year summation consists of the expenditures for the year stated plus the expenditures for the four previous years.

## GOVERNMENT NON-RECURRING EXPENDITURES URBANSVILLE HIGH MARKET PENETRATION

Non Discounted, Five Year Summations

		Non-Recurring Expenditures		
		Yrs	Yrs	Yrs
Subsystem	Subsystem Name	1-5	6-10	11-20
CVAS	Commercial Vehicle Administration Subsystem	\$379	\$1	\$16
CVCS	Commercial Vehicle Check Subsystem	\$326	\$0	\$80
EMS	Emergency Management Subsystem	\$406	\$309	\$792
EMMS	Environmental And Emissions Management Subsystem	\$1	\$0	\$0
EVS	Emergency Vehicle Subsystem	\$1,867	\$4,855	\$12,560
PMS	Parking Management Subsystem	\$645	\$920	\$3,625
PS	Planning Subsystem	\$0	\$35	\$35
RS	Roadside Subsystem	\$66,969	\$95,737	\$224,677
RTS	Remote Traveler Subsystem	\$1,600	\$3,125	\$12,100
TAS	Toll Administration Subsystem	\$56	\$10	\$60
TCS	Toll Collection Subsystem	\$315	\$0	\$168
TMS	Traffic Management Subsystem	\$4,738	\$5,662	\$15,721
TRMS	Transit Management Subsystem	\$3,089	\$3,168	\$270
TRVS	Transit Vehicle Subsystem	\$10,220	\$13,236	\$29,788

Expenditures are in constant 1995 dollars in (1,000's)

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# GOVERNMENT NON-RECURRING EXPENDITURES THRUVILLE HIGH MARKET PENETRATION

Non Discounted, Five Year Summations

		Non-Recurring Expenditures		
		Yrs	Yrs	Yrs
Subsystem	Subsystem Name	1-5	6-10	11-20
CVAS	Commercial Vehicle Administration Subsystem	\$676	\$1	\$32
CVCS	Commercial Vehicle Check Subsystem	\$809	\$6	\$202
EMS	Emergency Management Subsystem	\$203	\$203	\$393
EMMS	Environmental And Emissions Management Subsystem	\$0	\$1	\$0
EVS	Emergency Vehicle Subsystem	\$895	\$2,321	\$5,380
PMS	Parking Management Subsystem	\$172	\$231	\$905
PS	Planning Subsystem	\$0	\$35	\$35
RS	Roadside Subsystem	\$6,648	\$92,638	\$89,690
RTS	Remote Traveler Subsystem	\$520	\$1,261	\$5,750
TAS	Toll Administration Subsystem	\$56	\$10	\$60
TCS	Toll Collection Subsystem	\$450	\$0	\$240
TMS	Traffic Management Subsystem	\$2,273	\$1,313	\$6,110
TRMS	Transit Management Subsystem	\$1,624	\$3,548	\$918
TRVS	Transit Vehicle Subsystem	\$3,649	\$4,327	\$9,193

Expenditures are in constant 1995 dollars in (1,000's)

## GOVERNMENT NON-RECURRING EXPENDITURES MOUNTAINVILLE HIGH MARKET PENETRATION

Non Discounted, Five Year Summations

		Non-Rec	urring Expe	nditures
		Yrs	Yrs	Yrs
Subsystem	Subsystem Name	1-5	6-10	11-20
CVAS	Commercial Vehicle Administration Subsystem	\$338	\$1	\$16
CVCS	Commercial Vehicle Check Subsystem	\$405	\$3	\$101
EMS	Emergency Management Subsystem	\$203	\$0	\$196
EMMS	Environmental And Emissions Management Subsystem	\$0	\$1	\$0
EVS	Emergency Vehicle Subsystem	\$2	\$8	\$17
PMS	Parking Management Subsystem	\$0	\$0	\$0
PS	Planning Subsystem	\$0	\$0	\$0
RS	Roadside Subsystem	\$0	\$1,094	\$1,572
RTS	Remote Traveler Subsystem	\$0	\$0	\$30
TAS	Toll Administration Subsystem	\$0	\$0	\$0
TCS	Toll Collection Subsystem	\$0	\$0	\$0
TMS	Traffic Management Subsystem	\$0	\$679	\$911
TRMS	Transit Management Subsystem	\$0	\$1,968	\$85
TRVS	Transit Vehicle Subsystem	\$0	\$133	\$137

Expenditures are in constant 1995 dollars in (1,000's)

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As expected the major government expenditure item in each of the deployments is the RS, with transit systems the next largest cost items. Using the methodology, and unit prices described in this document, a public sector implementor can make their own set of assumptions and compute both recurring and non-recurring expenditures.

Tabulated below are the non-recurring and recurring expenditures for an individual user for three levels of service. Basic service provides the capability for drivers to interface with the ISP Subsystem's Basic Information Broadcast Equipment Package, receive formatted traffic advisories including accurate traveling information concerning available travel options, their availability, and congestion information in their vehicle. Basic Service also provides Vehicle MAYDAY service. Mid-range Service provides the Basic services plus In-Vehicle hardware, and software for Vehicle Route Guidance and Interactive Vehicle Reception. The comprehensive Service provides the Basic and Mid-range Services plus equipment for In-Vehicle Signing, Probe Vehicle Software, Smart Probe, and Vehicle Route Guidance.

## INDIVIDUAL NON-RECURRING EXPENDITURES

Basic Service	\$450
Mid-range Service	\$1,350
Comprehensive Service	\$2,500

If all vehicle Equipment Packages including safety systems and AHS are combined, the total per vehicle non-recurring expenditure is \$8,310.

### INDIVIDUAL MONTHLY RECURRING EXPENDITURES

	Operation	Maintenance
Basic Service	\$10	\$1
Mid-range Service	\$35	<\$5
Comprehensive Service	\$35	<\$8

The total monthly cost for in-vehicle ATIS services are in the range of \$0 to \$43 per month for individual users (based on average usage) and are comparable to current service cost experiences for cellular telephone service.

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### 1. INTRODUCTION

The goal of the cost analysis for Phase 2 of the National ITS Architecture project is twofold. First, the evaluation is to produce a high-level estimate of the expenditures associated with implementing the physical elements and the functional capabilities of ITS Services as these services are likely to be deployed under the confines of the National ITS Architecture. The second goal of the cost evaluation is to provide a costing tool for ITS implementors. The range of unit prices and quantities provided throughout the evaluation may be used by public and private stakeholders in determining appropriate deployment plans and strategies.

For the first goal, the analysis addresses expenditures for equipment deployment, as well as operations and maintenance for the subsystems identified in the physical architecture. The cost evaluation is based on the Phase 2, physical architecture configuration which includes the subsystem listed below.

- 1. Commercial Vehicle Administration Subsystem (CVAS)
- 2. Commercial Vehicle Check Subsystem (CVCS)
- 3. Commercial Vehicle Subsystem (CVS)
- 4. Emergency Management Subsystem (EM)
- 5. Emissions Management Subsystem (EMMS)
- 6. Emergency Vehicle Subsystem (EVS)
- 7. Fleet Management Subsystem (FMS)
- 8. Information Service Provider Subsystem (ISP)
- 9. Personal Information Access Subsystem (PIAS)
- 10. Parking Management Subsystem (PMS)
- 11. Planning Subsystem (PS)
- 12. Roadway Subsystem (RS)
- 13. Remote Traveler Support Subsystem (RTS)
- 14. Toll Administration Subsystem (TAS)
- 15. Toll Collection Subsystem (TCS)
- 16. Traffic Management Subsystem (TMS)
- 17. Transit Management Subsystem (TRMS)
- 18. Transit Vehicle Subsystem (TRVS)
- 19. Personal Vehicle Subsystem (VS)

The relationships of the architecture subsystems in terms of their interconnections are illustrated in the Architecture Interconnect Diagram, located in the Physical Architecture Document. The cost evaluations are based upon a detailed physical element categorization within each subsystem and an aggregation of total expenditures into initial investment (non-recurring) expenditures, as well as operation and maintenance (recurring) expenditures. The products of the analyses include the following:

(1) an expenditure profile for the ITS life cycle. The analysis also addresses the allocation of expenditures among three stakeholder groups, government, commercial

- and private consumers. The allocation of expenditures is correlated to the benefits analysis, provided under a separate deliverable,
- (2) some examples of existing technology and price ranges for implementing Equipment Packages,
- (3) En estimating tool for implementors of ITS systems.

In accordance with FHWA costing guidelines, the phase two analyses include the cost evaluation of three distinct deployment scenarios. These scenarios are described in detail in the Evaluatory Design Document. Each scenario represents a typical geographical area for implementing the architecture into deployment services. Not all services are deployed in each scenario. However, among the three scenarios, each ITS service is deployed in at least one area. The analyses assume a twenty-year deployment period in which time the operations and maintenance activities are included.

The second goal of the cost evaluation provides the range of unit prices and quantities throughout the evaluation to be used by public and private stakeholders in determining appropriate deployment plans and strategies. The major emphasis for the phase two evaluation is to provide a costing methodology and ranges of unit prices for the various ITS services. The expenditures for the scenarios serve as an example in implementing the costing methodology.

The accuracy of any cost evaluation is a function of evaluating the state-of-the-practice, the state-of-the-art, or the yet to be defined technology. The delivery of ITS services to the end user encompasses all three of these situations. Where the state-of-the-practice technology is being deployed in the delivery of ITS services, the accuracy of the cost evaluation is significantly better than cost estimates for developing technology and those technologies which are still in the research stages. This being the case, the unit prices for near term deployed and currently deployed ITS systems rely on existing price catalogs, state's department of transportation construction pay item ranges, as well as other public records including construction bid unit prices. Where feasible, a range of estimates is provided for specific technology equipment. This range should be balanced with local construction pricing indices, such as the Means Cost Estimating Indices.

### 1.1 Organization of Report

This cost evaluation report is separated into seven main chapters, with chapters five, six, and seven containing the expenditure analyses for the three identified scenario deployments. Chapters one is the Introduction. Chapter two outlines the objectives of the National ITS Architecture Cost Evaluation. Chapter three provides a basic definition of the terms utilized in the costing exercise. The relationships of ITS User Services to the deployable physical devices which provide the required functionality of the services is provided in the following chapter. Chapter four, the heart of the document, details the method for determining expenditures for each ITS service through the deployment of Equipment Packages. This chapter provides the cost analysis for determining the expenditures for each Equipment Package based on any specified scenario. Chapters five, six, and seven, are examples of

expenditure calculations for the specified scenarios, Urbansville, Thruville, and Mountainville, respectively. These chapters execute the methodology outlined in chapters three, and four, as well as demonstrate the assumptions necessary in determining the costing parameters.

### 1.2 Relationship to Other Documents

This report is written as part of a series of reports for the National ITS Architecture Program. While much of this report may be used without outside reference, there is specific reliance of the Cost Evaluation on several of the other documents. A list of deliverable documents upon which this analysis relies follows:

Physical Architecture Logical Architecture Theory of Operations Implementation Strategy Evaluatory Design Communications

The Physical and Logical Architecture Documents represent the core descriptions of the national architecture structure. Their relationship to the cost document is significant in that the bases for the cost evaluation are deployment scenarios as functions of the national architecture. These documents provide details on the standards, protocols, and interconnections for the various subsystems in the architecture.

The Theory of Operations Document provides a description of how the architecture provides for user services. The concepts of this document have been incorporated into the Cost Evaluation document through the establishment of sample deployment scenarios.

The Implementation Strategy describes the various issues and concerns in deploying ITS services. Stakeholder relationships, required interactions, and potential partnerships are detailed as they relate to implementing various services. The Cost Evaluation document utilizes these concepts in formulating expenditures by stakeholder group.

The Evaluatory Design Document (EDD) is the greatest source of information for the Cost Evaluation Document. The EDD identifies the parameters utilized to evaluate the architecture. For the second phase, sample deployment scenarios are described for a typical urban area (Urbansville), a typical interurban corridor (Thruville), and a typical rural area (Mountainville.) Basic parameters for each of these sample deployments are detailed in the EDD. Some specific parameters which are only used for the sample cost evaluation are described below, in the Sample Expenditure Calculation sections for each scenario.

The Communications Document is correlated to the Evaluatory Design Document so that the data loading analysis parameters coincide for the various evaluation activities. The cost evaluation utilizes the parameters from the EDD directly.

### 1.3 Relationship to National ITS Architecture

The National ITS Architecture represents the framework for the conceptual description of subsystems, standards, protocols, performance objectives, and interactions which form the basis for user services for ATIS, ATMS, CVO, APTS and AVVS, and for their system interconnectivity, allowing the integration of a national system which promotes compatibility, flexibility, expandability, and openness. This Cost Evaluation Document contains an evaluation of expenditures for sample deployments of ITS services. By its nature, a cost for the architecture itself cannot be quantified. What is quantified is the expenditure of sample implementations of the architecture, or system designs of ITS service deployments. As sample deployments, these evaluated implementations do not fully encompass the deployment variations possible under the architecture framework.

Cost issues which are associated with the architecture but are not included in the cost evaluation include the negative costs (or cost savings) from having a national architecture program. For example, one of the driving forces in establishing a national architecture was the desire to efficiently utilize the country's resources and avoid the wasteful expense of multiple and duplicative efforts in technology development for advancing the ITS services. These types of expenditures cannot be easily estimated. Projected research and development expenditures are very subjective and highly volatile.

Other costs associated with the architecture which are not included in the cost evaluation include the costs for monitoring compliance to the architecture. It is anticipated that the benefits of complying with a national compatibility framework are sufficient incentives for federal, state, local, private developer and commercial compliance. The risks associated with noncompliance, and its effect on the ITS deployments are described in the Feasibility/Risk Document.

### 1.4 Relationship to Typical Deployments

As part of the National ITS Architecture Program, Cost Analysis, typical deployment scenarios have been developed. The three scenarios described in the Evaluatory Design Document detail ITS Services deployed in three types of regions: a highly congested urban area, a moderately congested interurban area, and a rural area. These scenarios are selected and crafted to test multiple aspects of the architecture program. In order to provide a coherent set of evaluations of the architecture, each evaluation activity, of which the cost evaluation is only one, utilizes the same evaluatory design scenario.

In an effort to make the architecture documents more usable for the implementors of ITS services, the Cost Evaluation Document is changed in structure from the phase one format. The Cost Evaluation Document is formatted to provide preliminary cost information for an implementor to begin planning. Under chapter five of this document the methodology for developing cost expenditure estimates for each ITS service is detailed. By selecting those services which are of interest to the implementor, a specific deployment scenario may be

developed that better suits the implementors' interests. A set of expenditures for those services may then be calculated.

### 2. OBJECTIVES

During the second phase, there were no officially issued revised guidelines. However, a series of evaluation meetings were held during the second phase, wherein the focus of the document was altered.

During the first phase of the project, the focus for the cost evaluation was to provide a mechanism for evaluating the disparate architectures developed by the four architecture teams. The focus for the second phase is to provide a useable report for a target audience of ITS implementors, i.e., those people which will be planning, formulating and implementing the deployment of ITS services in their local area. These implementors generally fall into two categories; category one: public agencies, or category two; private entrepreneurs, and commercial businesses.

The objectives of the phase two cost evaluation of the National ITS Architecture can be summarized as follows:

- 1. To produce a high-level cost estimate of the implementation of the functional capabilities supported by the architecture.
- 2. To allocate expenditures to the stakeholder group bearing the expenditure ("who pays, who benefits").
- 3. To allocate expenditures into recurring, and non-recurring (including life cycle expenditures) categories.
- 4. To support analysis of design tradeoffs and provide expenditure data for analyzing the implementation alternatives.
- 5. To support the benefits and performance analyses by addressing the allocation of expenditures to stakeholder groups.
- 6. To develop quantity, prices and expenditure estimates of the ITS architecture implementation to aid in FHWA's overall evaluation of alternative implementation strategies.
- 7. To develop estimates of the level and time line of the estimated government investment necessary for the ITS architecture deployment.
- 8. To develop and identify the level of government investment and private entrepreneur potential for deployment of Core Infrastructure components.
- 9. To identify those elements of the architecture that represent dominant cost features, the projected time-lines for incurring these costs and the entities projected to absorb these costs.
- 10. To provide elemental costs for implementors, which allow the Equipment Package Unit Price Worksheets to be utilized in costing ITS implementations for any designated deployment.

### 3. EQUIPMENT PACKAGE DEFINITION

The expenditures and unit prices utilized in this ITS National Architecture Evaluation represent the final **price** of the installed equipment, not the manufacturer's **cost** of production. This is an important point in differentiating between **price** and **cost**. A manufacturer's **cost** of production is only one factor in determining the final price for a product which the market will bear and for which a reasonable profit may be made. Research and development costs, production costs, transportation costs, intermediary shippers' and handlers' costs, marketing costs, and retail markups are all a part of the determination of the final retail price of a product. These items are very difficult to estimate in developing manufacturing industries. Therefore, the expenditures presented in this analysis represent estimates of retail prices for equipment and staff based on comparable technology retail pricing, or estimates of market prices based on historical pricing strategies for specific industries.

Formulating Unit Prices for certain devices, specifically the in-vehicle electronics products, involves cost recovery concepts and the following considerations:

- ♦ The total cumulative volume of that product which will be sold to all possible customers, over a period of years.
- ♦ The cost of software per product that is generally spread across all customer volumes, but includes considerations that a portion of that software was used previously, and / or if it can be shared by another product under development.
- ♦ Considerable tooling expense, and test equipment capital expense in the manufacturing of electronics.
- The cost of product recall if it is related to the safety or emissions;
- ◆ Target pricing policies. In the present day automobile manufacturing environment, it is common practice to operate with a policy of target pricing, wherein the component product supplier is given a specified selling price. This policy invariably leads to a negotiating process involving component product specifications, and quality control issues.

In view of these considerations, the approach adopted in the development of Unit Prices is to compare Equipment Packages to similarly available commercial products. In addition, these comparisons are tempered by the likely total volumes of the product by a given supplier. This is evident within the vehicle subsystem where low unit prices are correlated to a high unit production quantities, and the high unit prices are correlated to low production quantities.

### 3.1 Basis for Definition

The basis for cost analysis is the subsystems and Equipment Packages of the Physical Architecture.

Subsystems perform transportation functions (e.g., collect data from the roadside, perform route planning, etc.) All of the functions are defined in the logical architecture as process specifications. Processes that are likely to be collected together under one physical agency, jurisdiction, or physical unit are grouped together into a subsystem. This grouping is done to optimize the overall expected performance of the resulting ITS deployments taking into consideration anticipated communication technologies, performance, risk, deployment, etc.

For a complete description of the subsystems of the National ITS Architecture refer to the Physical Architecture Document. The Equipment Packages represent subsets of functionality within a single Subsystem. Each Equipment Package is described in the following sections 5.6.1 through 5.6.19.

### 4. METHODOLOGY

As stated earlier in this document, one of the goals of the Phase II national architecture cost evaluation process is to produce a usable document for a target audience of ITS Service Implementors. These implementors include federal, state, and local government planners, and politicians, as well as the commercial industry, and the individual entrepreneurs seeking to conceptually estimate the costs for system deployments. This section of the report responds to this goal by outlining the steps necessary in determining a specific ITS deployment scenario's expenditures that are independent from the prescribed Urbansville, Thruville, and Mountainville scenarios provided by FHWA.

For reference, sample calculations for deployed services are provided in the following chapters for the prescribed typical areas, the urban area, interurban area, and rural area. The cost evaluation in these later chapters evaluates five, ten and twenty year deployment milestones as specified in the Phase II Deliverable Guidelines. The analyses also assumes operations and maintenance schedules for this period, during which all devices remain operable and expenditures required to facilitate the Market Packages are incurred through life cycle costing.

### 4.1 Summary of Approach

The cost evaluation is conducted based on 1995 constant dollars for the unit prices in determining Equipment Package expenditure. The evaluation approach discussed below is that which was applied by the Architecture Team in evaluating the ITS National Architecture. This approach may be used by other implementors of ITS services in determining conceptual pricing and expenditures for various services. The essential steps in cost evaluations are outlined below:

- 1. Definition of the ITS baseline. This baseline represents a reference point for the development and cost analysis of a future deployment.
- 2. Identification of ITS User Services and possible combinations of architecture functionality to be bundled into Market Packages that provide various levels of service to the users at various costs. The selection of Equipment Packages for similar User Services will span across Subsystems, as Market Packages require the functionality from multiple architectural Subsystems.
- 3 Examination of the lists of equipment as itemized in the Equipment Package Worksheets for such user services.
- 4 Examination of unit prices for end user services and/or packages of such equipment.
- Identification and evaluation of equipment, markets/quantities and timing for a local deployment.

- 6 Calculation of the parametric quantities.
- 7 Calculation of the expenditure matrices for Equipment Packages.
- 8 Summation of Equipment Package expenditures to determine Market Packages expenditures.

The outputs of this analysis are the following:

- Equipment Package identification and existing technology components listing.
- ♦ Matrix tying Equipment Packages to architectural elements.
- ♦ Matrices of Quantities one for each stakeholder group for each scenario (identified in the Evaluatory Design Document.)
- Matrices of unit prices for each Equipment Package.
- ♦ Matrices of expenditures for each Equipment Package, for each stakeholder group, for the specific scenario, for the analysis period.
- Discounted present values for the expenditure matrices.

### 4.2 The Goal of Cost Evaluation, End User Expenditures

End user expenditures, for any deployment, are the results of multiplying the quantities of items purchased for that deployment with the unit prices for each quantity item to be deployed in the scenario. The end user expenditures may be segregated by purchasing sectors and by year. The Equipment Packages, the basis for pricing strategies of an ITS deployment, are segregated by the architectural Subsystems. Each Equipment Package will have a time period of deployment, defined by the planned evolutionary deployment. Depending on the particular deployment scenario, or the implementor's interests, end user expenditures may be segregated into differing stakeholder groups, or purchasing sectors.

The three broad classifications of stakeholder groups are the Individual/Private Consumer, the Commercial Sector, and the Public/Government Sector. For every Equipment Package, there are two financial flows: (1) non-recurring expenditures, the initial funding or financing of service delivery and (2) recurring expenditures, the expenditures for continual operation and maintenance of the Equipment Packages.

Non-recurring expenditures are those which would be mostly attributable to a one-time capital investment sufficient for the useful life of the equipment necessary for the applicable service. Recurring expenditures are those expenditures which are attributable to the operation and maintenance of the ITS service. These expenditure items include consumables

for the equipment as well as for service fees and access expenditures. Replacement devices with useful lives of one year or less are included in the recurring expenditure tabulations.

### 4.3 Life Cycle Costing

Life cycle expenditures for the non-recurring items are accounted for by full replacement at the end of the scheduled useful life. These life cycle replacements may be included in the non-recurring expenditures throughout the entire deployment period and operation period for the evaluation. For the sample calculation scenarios in the following chapters the deployment period encompasses twenty years, beginning in 1993.

Specific technology selection for each deployment is specified in this cost evaluation document for the purposes of cost estimating. This technology, whether state-of-the-practice, state-of-the-art, or in its development phase is not specifically endorsed by the national architecture. The national architecture is not a deployment design. However, in order to evaluate the architecture some initial deployment design is needed. The design information is provided as a baseline from which future technological improvements may be judged. For example, the unit prices for the Roadway Subsystem include installations of loop detectors. These loop detectors have an estimated capital cost, an estimated operation and maintenance cost, and an estimated useful life. Other technology which has been classified as state-of-the-art that is currently being used includes video technology. The video monitoring industry is well aware of the current state-of-the-practice use of loop detectors and the subsequent life cycle costs are the main competition. Many factors are weighed in deciding a specific technology design, including full life cycle cost evaluation, safety, reliability, etc.

The life cycle expenditures for alternative technology used in Equipment Packages may be evaluated and compared using the baseline deployment technology listed in the Worksheets.

### 4.4 Analytical Tools

Included with this document are spreadsheets for calculating end user expenditures for specific deployments, and other variations on the three FHWA provided scenarios. These spreadsheets include an analysis time frame for the three scenarios. These parameters may be altered for different scenario analyses.

In these spreadsheets the annual expenditures are tabulated in the matrix for a total of twenty years. As certain Market Packages are deployed and become operational, the recurring operation and maintenance expenditures become activated, and the life cycle for the system components begins.

The Equipment Package Unit Price Worksheets contain the itemized listings of equipment, such as sensors, communication apparatus, processing requirements, interfaces (workstations), as well as additional staffing requirements, equipment maintenance requirements, and operations required communications.

Other analytical tools include, the previously mentioned Table 4.5.2-1, which details the relationship of Equipment Packages and Architecture Subsystems to Market Packages, as well as the Evaluatory Design Document, which describes the sample deployments for prescribed areas. These assumptions and deployment designs for the three typical design scenarios provide some insight into selecting parameters for each Equipment Package.

### 4.5 Analytical Procedure

The cost evaluation procedure objective is the expenditure profile for a particular stakeholder, or several stakeholders, for any ITS User Service or Market Package. The expenditure profile includes a time frame for analysis in order to evaluate life cycle costs, as well as to obtain a feeling for the relative dimensions of non-recurring costs (initial capital expenditures) and recurring costs (annual operation and maintenance expenditures.)

### **4.5.1** Definition of ITS Baseline

For the purposes of the National ITS Architecture development project, the ITS baseline is a definition of a no ITS baseline. That is, the baseline for analysis assumes that there is no current ITS technology deployed. For each implementor's scenario, an inventory of existing systems is necessary. This inventory includes such items as signal controller technology, existing closed loop signal controls, existing traffic control/management facility capabilities and limitations, existing transit facility technology, existing emergency facilities, existing communication network along the roadway infrastructure, etc.

A starting point for the development of this inventory is contained in the Evaluatory Design Document. Specifically, the lists of parameters, and the list of bases of estimates for each of the analysis scenarios are included.

### 4.5.2 Market Package Selection

The next step is to determine which Market Packages are to be implemented. To some degree, the selection of Market Packages (i.e. User Services) to be deployed is a function of the estimated expenditures. Once the proposed User Services are selected for expenditure analysis, then the selection of the specific Market Packages that encompass the User Services is required. For the prescribed scenario analyses, the selection of the User Services and Market Packages is contained in the scenario descriptions. For purposes of evaluation activities, all User Services and all Market Packages are evaluated through the three scenarios, at least once. The deployment timing for Equipment Packages is detailed in the Evaluatory Design Document.

Following the selection of Market Packages, the Matrix in Table 4.5.2-1, may be employed to determine which Architecture Subsystems are involved, and which pieces of those Subsystems, the Equipment Packages, are required.

Table 4.5	.2-1 Market Package to Equipment	Package	Relationship
Market	Market Package Name	Sub-	Equipment Package Name
Package		system	
APTS1	Transit Vehicle Tracking	TRMS	Transit Center Tracking and Dispatch
APTS1	Transit Vehicle Tracking	TRVS	On-board Trip Monitoring
APTS2	Transit Fixed-Route Operations	TRMS	Transit Center Fixed-Route Operations
APTS2	Transit Fixed-Route Operations	TRVS	Vehicle Dispatch Support
APTS3	Demand Response Transit Operations	ISP	Interactive Infrastructure Information
APTS3	Demand Response Transit Operations	PIAS	Personal Interactive Information Reception
APTS3	Demand Response Transit Operations	TRMS	Transit Center Paratransit Operations
APTS3	Demand Response Transit Operations	TRVS	On-board Transit Driver I/F
APTS3	Demand Response Transit Operations	RTS	Remote Interactive Information Reception
APTS4	Transit Passenger and Fare Management	RTS	Remote Transit Fare Management
APTS4	Transit Passenger and Fare Management	TRMS	Transit Center Fare and Load Management
APTS4	Transit Passenger and Fare Management	TRVS	On-board Transit Fare and Load Management
APTS5	Transit Security	TRVS	On-board Transit Security
APTS5	Transit Security	RTS	Remote Transit Security I/F
APTS5	Transit Security	TRMS	Transit Center Security
APTS5	Transit Security	EM	Emergency Response Management
APTS6	Transit Maintenance	TRMS	Fleet Maintenance Management
APTS6	Transit Maintenance	TRVS	On-board Maintenance
APTS7	Multi-modal Coordination	RS	Roadside Signal Priority
APTS7	Multi-modal Coordination	TRMS	Transit Center Multi-Modal Coordination
APTS7	Multi-modal Coordination	TMS	TMC Multi-Modal Coordination
APTS7	Multi-modal Coordination	TRVS	On-board Vehicle Signal Coordination
ATIS1	Broadcast Traveler Information	RTS	Remote Basic Information Reception
ATIS1	Broadcast Traveler Information	PIAS	Personal Basic Information Reception
ATIS1	Broadcast Traveler Information	ISP	Basic Information Broadcast
ATIS1	Broadcast Traveler Information	RTS	Remote Basic Information Reception
ATIS1	Broadcast Traveler Information	VS	Basic Vehicle Reception
ATIS2	Interactive Traveler Information	PIAS	Personal Interactive Information Reception
ATIS2	Interactive Traveler Information	RTS	Remote Interactive Information Reception
ATIS2	Interactive Traveler Information	VS	Interactive Vehicle Reception
ATIS2	Interactive Traveler Information	RTS	Remote Interactive Information Reception
ATIS2	Interactive Traveler Information	ISP	Interactive Infrastructure Information
ATIS3	Autonomous Route Guidance	VS	Vehicle Route Guidance
ATIS3	Autonomous Route Guidance	PIAS	Personal Route Guidance
ATIS4	Dynamic Route Guidance	VS	Basic Vehicle Reception
ATIS4	Dynamic Route Guidance	VS	Vehicle Route Guidance
ATIS4	Dynamic Route Guidance	ISP	Basic Information Broadcast
ATIS4	Dynamic Route Guidance	VS	In-Vehicle Signing System
ATIS4	Dynamic Route Guidance	PIAS	Personal Route Guidance
ATIS4	Dynamic Route Guidance	PIAS	Personal Basic Information Reception
ATIS5	ISP Based Route Guidance	VS	Vehicle Route Guidance
ATIS5	ISP Based Route Guidance	VS	Interactive Vehicle Reception
ATIS5	ISP Based Route Guidance	ISP	Interactive Infrastructure Information
ATIS5	ISP Based Route Guidance	PIAS	Personal Route Guidance
ATIS5	ISP Based Route Guidance	ISP	Infrastructure Provided Route Selection
ATIS5	ISP Based Route Guidance	PIAS	Personal Interactive Information Reception

<b>Table 4.5</b>	.2-1 Market Package to Equipment I	Package	Relationship
Market	Market Package Name	Sub-	Equipment Package Name
Package		system	
ATIS6	Integrated Transportation	TMS	TMC Advanced Signal Control
	Management/Route Guidance		
ATIS6	Integrated Transportation	ISP	ISP Advanced Integrated Control Support
	Management/Route Guidance		
ATIS6	Integrated Transportation	VS	Vehicle Route Guidance
	Management/Route Guidance		
ATIS6	Integrated Transportation	VS	Interactive Vehicle Reception
	Management/Route Guidance		•
ATIS6	Integrated Transportation	ISP	Interactive Infrastructure Information
	Management/Route Guidance		
ATIS7	Yellow Pages and Reservation	VS	Interactive Vehicle Reception
ATIS7	Yellow Pages and Reservation	ISP	Interactive Infrastructure Information
ATIS7	Yellow Pages and Reservation	RTS	Remote Interactive Information Reception
ATIS7	Yellow Pages and Reservation	ISP	Infrastructure Provided Yellow Pages &
	5		Reservation
ATIS7	Yellow Pages and Reservation	PIAS	Personal Interactive Information Reception
ATIS8	Dynamic Ridesharing	RTS	Remote Interactive Information Reception
ATIS8	Dynamic Ridesharing	ISP	Infrastructure Provided Dynamic Ridesharing
ATIS8	Dynamic Ridesharing	PIAS	Personal Interactive Information Reception
ATIS8	Dynamic Ridesharing	ISP	Interactive Infrastructure Information
ATIS8	Dynamic Ridesharing	VS	Interactive Vehicle Reception
ATIS9	In Vehicle Signing	TMS	TMC Input to In-Vehicle Signing
ATIS9	In Vehicle Signing	VS	In-Vehicle Signing System
ATIS9	In Vehicle Signing	RS	Roadway In-Vehicle Signing
ATMS01	Network Surveillance	TMS	Collect Traffic Surveillance
ATMS01	Network Surveillance	RS	Roadway Basic Surveillance
ATMS02	Probe Surveillance	RS	Roadway Probe Beacons
ATMS02	Probe Surveillance	VS	Probe Vehicle Software
ATMS02	Probe Surveillance	TMS	TMC Probe Information Collection
ATMS02	Probe Surveillance	ISP	Interactive infrastructure information
ATMS02	Probe Surveillance	VS	Vehicle Toll/Parking interface
ATMS02	Probe Surveillance	VS	Interactive Vehicle Reception
ATMS02	Probe Surveillance	ISP	ISP Probe Information Collection
ATMS03	Surface Street Control	TMS	Traffic Maintenance
ATMS03	Surface Street Control	RS	Roadway Signal Controls
ATMS03	Surface Street Control	TMS	TMC Basic Signal Control
ATMS04	Freeway Control	TMS	Traffic Maintenance
ATMS04	Freeway Control	TMS	TMC based freeway control
ATMS04	Freeway Control	RS	Roadway Freeway Control
ATMS04	Freeway Control	TMS	TMC Incident Detection
ATMS04	Freeway Control	RS	Roadway Incident Detection
ATMS05	HOV and Reversible Lane Management	RS	Roadway HOV Usage
ATMS05	HOV and Reversible Lane Management	TMS	TMC HOV/Reversible Lane Management
ATMS05	HOV and Reversible Lane Management	RS	Roadway Reversible Lanes
ATMS06	Traffic Information Dissemination	TMS	TMC Traffic Information Dissemination
ATMS06	Traffic Information Dissemination	RS	Roadway Traffic Information Dissemination
	Regional Traffic Control	TMS	TMC Regional Traffic Control
ATMS07			
ATMS07 ATMS08	Incident Management System	ElVI	Emergency Response Management
ATMS08	Incident Management System Incident Management System	EM TMS	Emergency Response Management TMC Incident Dispatch
	Incident Management System Incident Management System	TMS	TMC Incident Dispatch Coordination/Communication

Table 4.5	.2-1 Market Package to Equipment 1	Package	Relationship
Market	Market Package Name	Sub-	Equipment Package Name
Package	č	system	
ATMS10	Dynamic Toll/Parking Fee Management	TMS	TMC Toll/Parking Coordination
ATMS10	Dynamic Toll/Parking Fee Management	PMS	Parking Management
ATMS10	Dynamic Toll/Parking Fee Management	TAS	Toll Administration
ATMS10	Dynamic Toll/Parking Fee Management	TCS	Toll Plaza Toll Collection
ATMS10	Dynamic Toll/Parking Fee Management	VS	Vehicle Toll/Parking Interface
ATMS11	Emissions and Environmental Hazards	EMMS	Emissions and Environmental Data
111112011	Sensing	2111112	Management
ATMS11	Emissions and Environmental Hazards	RS	Roadway Pollution and Environmental
111112011	Sensing	11.0	Hazards Indicators
ATMS12	Virtual TMC and Smart Probe Data	TMS	Distributed Road Management
ATMS12	Virtual TMC and Smart Probe Data	RS	Roadway Probe Beacons
ATMS12	Virtual TMC and Smart Probe Data	VS	In-vehicle Signing System
ATMS12	Virtual TMC and Smart Probe Data	VS	Smart Probe
ATMS12	Virtual TMC and Smart Probe Data  Virtual TMC and Smart Probe Data	RS	Automated road signing
AVSS01	Vehicle Safety Monitoring	VS	Vehicle Safety Monitoring System
AVSS01 AVSS02	Driver Safety Monitoring	VS	Driver Safety Monitoring System
AVSS02 AVSS03	Longitudinal Safety Warning	VS	Vehicle Longitudinal Warning System
	Lateral Safety Warning	VS	Vehicle Lateral Warning System
AVSS04		VS VS	
AVSS05	Intersection Safety Warning	RS RS	Vehicle Intersection Collision Warning
AVSS05	Intersection Safety Warning		Roadway Intersection Collision System
AVSS05	Intersection Safety Warning	TMS	TMC Multi-Modal Coordination
AVSS06	Pre-Crash Restraint Deployment	VS	Vehicle Pre-Crash Safety Systems
AVSS07	Driver Visibility Improvement	VS	Driver Visibility Improvement System
AVSS08	Advanced Vehicle Longitudinal Control	VS	Vehicle Longitudinal Control
AVSS09	Advanced Vehicle Lateral Control	VS	Vehicle Lateral Control
AVSS10	Intersection Collision Avoidance	RS	Roadway Intersection Collision System
AVSS10	Intersection Collision Avoidance	VS	Vehicle Intersection Control
AVSS11	Automated Highway System	RS	Roadway Systems for AHS
AVSS11	Automated Highway System	TMS	TMC for AHS
AVSS11	Automated Highway System	VS	Vehicle Systems for AHS
CVO01	Fleet Administration	ISP	Infrastructure Provided Route Selection
CVO01	Fleet Administration	FMS	Fleet Maintenance Management
CVO01	Fleet Administration	CVS	On-board Trip Monitoring
CVO01	Fleet Administration	FMS	Fleet Administration
CVO02	Freight Administration	CVS	On-board Cargo Monitoring
CVO02	Freight Administration	FMS	Freight Administration and Management
CVO03	Electronic Clearance	CVS	On-board CV Electronic Data
CVO03	Electronic Clearance	CVCS	Roadside Electronic Screening
CVO03	Electronic Clearance	CVAS	CV Information Exchange
CVO04	CV Administrative Processes	CVAS	Credentials and Taxes Adminstration
CVO04	CV Administrative Processes	FMS	Fleet Credentials and Taxes Management and Reporting
CVO05	International Border Electronic Clearance	CVCS	International Border Crossing
CVO05	International Border Electronic Clearance	CVAS	CV Information Exchange
CVO05	International Border Electronic Clearance	FMS	Fleet Credentials and Taxes Management and
C + 003	memanonal Bolder Electronic Cicarance	1 1/10	Reporting
CVO05	International Border Electronic Clearance	CVS	On-board CV Electronic Data
	International Border Electronic Clearance International Border Electronic Clearance		International CV Administration
CVO05		CVAS	
CVO06	Weigh-In-Motion	CVS	On-board CV Electronic Data
CVO06	Weigh-In-Motion	CVCS	Roadside WIM
CVO07	Roadside CVO Safety	CVCS	Citation and Accident Electronic Recording

Table 4.5	.2-1 Market Package to Equipment l	Package	Relationship
Market	Market Package Name	Sub-	Equipment Package Name
Package	_	system	
CVO07	Roadside CVO Safety	CVAS	CV Information Exchange
CVO07	Roadside CVO Safety	CVAS	CV Safety Adminstration
CVO07	Roadside CVO Safety	CVCS	Roadside Safety Inspection
CVO07	Roadside CVO Safety	CVS	On-board CV Electronic Data
CVO08	On-board CVO Safety	CVAS	CV Information Exchange
CVO08	On-board CVO Safety	CVS	On-board CV Safety
CVO08	On-board CVO Safety	CVAS	CV Safety Administration
CVO08	On-board CVO Safety	CVS	On-Board Trip Monitoring
CVO08	On-board CVO Safety	CVCS	Citation and Accident Electronic Recording
CVO09	CVO Fleet Maintenance	FMS	Fleet Maintenance Management
CVO09	CVO Fleet Maintenance	CVS	On-board Trip Monitoring
CVO10	HAZMAT Management	EM	Emergency Mayday and E-911 I/F
CVO10	HAZMAT Management	EM	Emergency Response Management
CVO10	HAZMAT Management	EM	Emergency and Incident Management
			Communication
CVO10	HAZMAT Management	CVS	Vehicle Mayday I/F
CVO10	HAZMAT Management	TMS	TMC Incident Dispatch
			Coordination/Communication
CVO10	HAZMAT Management	CVS	On-Board Cargo Monitoring
CVO10	HAZMAT Management	FMS	Fleet HAZMAT Management
EM1	Emergency Response	EM	Emergency and Incident Management
			Communication
EM1	Emergency Response	EVS	On-board EV Incident Management
			Communication
EM1	Emergency Response	EM	Emergency Response Management
EM2	Emergency Routing	EM	Emergency Vehicle Routing and
			communications
EM2	Emergency Routing	ISP	EM Route Plan Information Dissemination
EM2	Emergency Routing	TMS	TMC Multi-Modal Coordination
EM2	Emergency Routing	EVS	On-board Vehicle Signal Coordination
EM3	Mayday Support	PIAS	Personal Mayday I/F
EM3	Mayday Support	EM	Emergency Mayday and E-911 I/F
EM3	Mayday Support	VS	Vehicle Mayday I/F
EM3	Mayday Support	RTS	Remote Mayday I/F
ITS1	ITS Planning	PS	Data Collection and ITS Planning

### **4.5.3** Identification of Architectural Subsystems

This step identifies the required subsystems for the implementation of Market Packages. Reference to Table 4.2, yields an immediate indication of the relationships. The table identifies the Equipment Packages (in alphabetical order). Going across the table, the architecture subsystem is identified and then the required Market Package(s). The Market Package is repeated each line for every additional Equipment Package required for the ITS service. For example, four Equipment Packages and the following three Subsystems provide the Transit Vehicle Tracking:

### **Equipment Package**

### Subsystem

Basic Information Broadcast	Information Service Provider
Transit Center Tracking and Dispatch	Transit Management Center
Interactive Vehicle Reception	Transit Vehicle Subsystem
On-Board Tracking System	Transit Vehicle Subsystem

### 4.5.4 Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the following sections. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and maintenance requirements. A review of the equipment listed and a comparison to the preferred local technology may yield different expenditure estimates. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology and developing technology, also using comparable technology.

The low range of the unit prices in the equipment worksheets were used for the evaluation of the prescribed scenarios. The anticipation is that the early deployment plans and developments for the 75 largest urban areas will provide the beginnings of a standardization of equipment, software, hardware, communications, and operations and maintenance. Local implementors may incorporate the price ranges provided, or per their discretion, adjust the price ranges. Some adjustments to the price ranges are recommended based on the following section.

### 4.5.5 Identification and Evaluation of Quantities and Market Size

For the Equipment Package parameters the quantity of items purchased influences the unit price for the equipment. Obviously, price breaks come into effect when larger quantities are purchased. One consideration to take into account, when developing the parametric quantities is the existing product development curve. For existing technology, many equipment prices are at a steady state price (exhibited in the far right columns of the Equipment Worksheets.) The prices are generally not subject to wide fluctuations based on quantities. Newer technology or services which are on the front end of a market/product development curve are subject to wide price ranges. Early deployments are obviously higher priced. The implementor may make a judgement as to the particular product development based on the existence of other similar systems in operation.

### **4.5.6** Calculation of Expenditure Matrices for Equipment Packages

Expenditure Matrices are calculated automatically through the linked spreadsheet programs. These files are submitted with the electronic version of this report, in government requested format. Included in the calculation are non-recurring expenditures (one-time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred during the year of deployment as indicated in the Evaluatory

Design Document deployment quantities for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets. This evaluation is important when considering comparative technologies and life cycle costs (see previous section on life cycle costing.)

### 4.5.7 Summary of Equipment Package Expenditures

This step in the cost evaluation process tabulates the Equipment Package expenditures for the stakeholder groups. Specifically, the government stakeholder expenditures are tallied for those Equipment Package which are attributable to government investment. These Equipment Packages are identified in the Evaluatory Design Document.

### 4.6 Equipment Package Worksheets

The Equipment Package Worksheets are grouped according to Subsystem. Within each Subsystem section, there is a discussion of equipment and assumptions utilized in developing the unit prices.

### **Common Equipment Throughout Subsystems**

Some common equipment across all subsystems are listed below. Primarily, this section describes the correlation to wireline and wireless unit prices which are derived from the Data Loading Analysis, as part of the evaluation activities for the program.

Wireline Communication levels stem from the communication layer of the architecture and the resulting usage rates for data, voice, and image transfer from Equipment Packages across subsystems and from Equipment Package to Equipment Package within each subsystem. The wireline unit prices are based on leased digital circuits, and on current pricing structure for telephone company provided circuits. These are based which appear to be the most feasible option notwithstanding the preferences of the local implementors.

A full life cycle cost analysis for the tradeoff of leased verses owned lines for implementors is a local study which must take into account many factors that are external to a strictly accounting function of life cycle costing. The information provided in this cost analysis may be used by local implementors as a comparison for these local studies.

The types of the leased lines for these circuits are grouped into three categories. These include the DS0 circuits which have a capacity of 56 Kbps, the DS1 circuits (comparable to a T1 rate) have a capacity of 1.544 Mbps, and the DS3 circuits which have a capacity of 44.736 Mpbs. Individual circuits may be multiplexed to provide a desired data rate that falls somewhere in the middle of these ranges.

The prices for these line types are based upon national averages for GTE services. National studies have found that some charges may vary as much as 100% between telephone companies and regions. The unit prices utilized represent both high and low ranges for typical leased lines. The typical distance from terminus to terminus for these prices is eight to fifteen miles, but most of the cost is not distance sensitive. The part of the communication link from the telephone central office to the equipment using the line is not a major component of the total line cost. The length of line between central telephone offices is the chief component of the unit prices. Many telephone companies have upgraded their central offices to digital transmission facilities thus providing the cost of analog leased lines, with a maximum guaranteed data rate of 9600 band, to be approximately the same cost as the DS0 digital lines. The unit prices for these lines are described below. The prices given may be discounted further (up to 50%) for multiple line users and long term (five year) commitments or contracts. This discounting is advantageous, but not relied upon for this cost analysis as the decisions for these discounts usually falls under the institutional layer of the architecture. These prices represent a snapshot in time given the uncertainty of the telecommunication industry.

Line	Available	Monthly	Price
Type	Capacity	Low	High
DS0	56Kbps	\$50	\$100
DS1	1.544Mbps	\$400	\$700
DS3	44.736Mbps	\$2000	\$6000

The wireless communication levels stem from the communication layer of the architecture and the resulting usage rates for data, voice, and image wireless transfer from Equipment Packages across subsystems and from Equipment Package to Equipment Package within each subsystem. CDPD prices are utilized as a comparative technology which will serve the functional requirements of the architecture. Other systems may be available which will meet the functional needs of the architecture and remain compliant with the standards and protocols. The selection of CDPD for this evaluation of the national architecture does not preclude these other systems. Rather, it provides a baseline for cost and functionality comparison.

The wireless unit prices utilized for this analysis, are based upon a recent announcement from GTE regarding CDPD prices. The prices for wireless communication are divided into three major categories, based on monthly usage from the data loading analysis. The unit prices are detailed below.

Usage	Available	Monthly	Rate per
Level	Usage	Price	<b>Additional Kbytes</b>
Low	125Kbytes	\$15	\$0.12
Medium	1,000Kbytes	\$50	\$0.08
High	3,000Kbytes	\$100	\$0.05

To derive a range of high and low unit prices, and to account for some individual variation in the monthly usage, the cost analyses utilizes the base monthly price as the low unit price, and increases the data loading analysis wireless communication requirements by 10% to calculate the high unit price, based on the usage level for each Equipment Package. For example, a wireless communication data loading analysis requirement result of 125Kbytes per month for an Equipment Package would have a low unit price of \$15 per month, and a high unit price of \$16.50 (10% extra, or 12.5Kbytes at \$0.12 = \$1.50 additional to the base monthly unit price of \$15.) The usage for each Equipment Package is derived from the data loading analysis, except for three transit vehicle Equipment Packages, TRV2, TRV3, and TRV7, which are described in section 4.6.18.

### 4.6.1. Commercial Vehicle Administration Subsystem (CVAS)

This subsystem contains the following Equipment Packages:

Equipment Package Name	Descriptor
Credentials and Taxes Administration	(CVA1)
CV Information Exchange	(CVA2)
CV Safety Administration	(CVA3)
International CV Administration	(CVA4)

Each Equipment Package is described below.

### 4.6.1.1 Credentials and Taxes Administration, (CVA1)

This Equipment Package provides administrative capabilities for commercial vehicle operations including database management and administrator-to-roadside and administrator-to-administrator interfaces. For example, this Equipment Package would manage the electronic credentials database for a state, perform reconciliation of mileage and fuel taxes (possibly post trip), and interface with roadsides performing credential checks. This Equipment Package communicates with similar packages in other CVAS locations to exchange credentials database information. Example locations would be state agency or regional offices that are involved with commercial vehicle operations.

### **4.6.1.2** CV Information Exchange, (CVA2)

This Equipment Package supports the exchange of safety and credentials data among jurisdictions. The package also supports the exchange of safety and credentials data between agencies (for example, an administrative center and the roadside check facilities) within a single jurisdiction. Data are collected from multiple authoritative sources and packaged into snapshots (top-level summary and critical status information) and profiles (detailed and historical data).

A software clearinghouse is used to maintain a database of carrier, id and driver numbers and status. The database also supports update and interrogation of these numbers. The software

may be set up as a collection of mirror sites each containing an up-to-date copy of specific information residing within some authorizing agency. Additional software is used to collect screening events to support tax filing reports for post trip reconciliation.

Additional staff is used to support maintaining the databases, updating database values based on inputs from the roadside and inputs from other CV centers.

Either leased line or privately installed line is used to other centers. Some centers may require higher performance than other centers. Some centers may get by with dialup capability.

### 4.6.1.3 CV Safety Administration, (CVA3)

This Equipment Package augments the Credentials and Taxes Administration Equipment Package with safety data. This package ensures that safety criteria are available for automated roadside safety checks. It supports the collection and review of carrier safety data and determines the carrier safety rating based on criteria supplied by Government Administration

This Equipment Package builds upon CVA2 equipment. An additional database is used as well as additional software upgrades. Additional software and processor capability are required to maintain databases and support updates to database from check stations.

### 4.6.1.4 International CV Administration, (CVA4)

This Equipment Package is used by government agencies such as customs and immigration, carriers, and service providers (e.g., brokers) to generate and process the entry documentation necessary to obtain release of vehicle, cargo, and driver across and international border, report the results of the crossing event, and handle duty fee processing.

This Equipment Package builds upon CVA2 equipment. An additional database is used as well as additional software upgrades. Additional database software is used to access international information and exchange international credentials with other agencies. Additional staff with expertise in international credential requirements. Staff is required to maintain databases and support updates to database from check stations.

# Equipment Package Unit Price Worksheet Equipment List and Price Ranges

# Credentials and Taxes Administration (CVA1)

	Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity C (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
			Int	roducto	Introductory State *	*			Steady State	state *
	Wireless Communication I/F	2	0.5	1			Exist. Technology	Iy	9.0	
(1	Electronic Credentials Purchase Software	20	20	40			Per Loral, Rockwell exper. in	vell exper. in	20	
uə	Database and Management for Post-Trip Processing &						Similar Integration Projects	n Projects		
	Electronic Credentials	20	40	100					40	
	Note: Software is off-the-shelf technology and unit price does									
ul l										
	Processor and Integration	20	200	220					200	
		10	15	30			Existing Technology Work-	logy Work-	15	
							stations for Operator Interface	ator Interface		
) Jiu	Communication Lines DS0 to CVCS & Financial Institution	20	0.5	_					0.5	
I)	Communication Lines DS1 to FMS	20	0.5	-					0.5	
			Int	roducto	Introductory State	* *			Steady State	state *
	CVCS & Financial Institution Wireline Communication DS0 from						Current Price Structure	ructure		
(ə:	Data Loading (see Common Equipment in Section 5.6)		9.0	1.2			from GTE		9.0	
gue										
uə	FMS Wireline Communication DS1 fro						Current Price Structure	ructure		
eni Jain	(see Common Equipment in Section 5.6)		4.8	8.4			from GTE		4.8	
curi S. & A	Additional Staff: 4 @ \$75,000									
	Note: Salary Costs are fully loaded prices (Base Salary,		270	330					270	
iter	Overtime, Overhead, Benefits, etc.)									
əd(										
O)	Maintenance for Processor @ 2% of Capital Cost		4	4.4					4	
	Maintenance for Workstations @ 2% of Capital Cost		0.3	9.0					0.3	
	Maintenance for Database & Software @ 2% of Capital Cost		1.2	2.8					1.2	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.1-1 CREDENTIALS AND TAXES ADMINISTRATION, (CVA1)

# Equipment Package Unit Price Worksheet Equipment List and Price Ranges

# CV Information Exchange (CVA2)

Quantity	tate *											tate *											
Unit Price	Steady State	0.5	0.5	20			0.5					Steady State	29					9.0		4.8		4.8	
Retail Price *		logy	logy	vell		ects	yology	S									ructure		Structure		Structure		
Comparative Technology		Existing Technology	Existing Technology	Per Loral, Rockwell	Exper. in similar	Integration Projects	Existing Technology										Current Price Structure	from GTE	Current Price	from GTE	Current Price Structure	from GTE	
Quantity (High)	te *											te *											
Quantity (Low)	Introductory State *											Introductory State											
Unit Price (High)	troduct	1	-	40			-					troduci	82					1.2		8.4		8.4	
Unit Price (Low)	므	0.5	0.5	20			0.5					l	29					9.0		4.8		4.8	
Years to Replacement (Life Cycle)		20	20	20			20																
Equipment Description		Communication Line DS0 to Enforcement Agency & DMV	Communication Line DS1 to Gov't. Admin.	Processor and Integration Add-on	Note: Software is off-the-shelf technology and unit price does	not reflect product development.	Communication Line DS1 to Planning Subsystem						Additional Staff (1 at \$75,000 average)	Note: Salary cost are fully loaded prices (Base salary,	overtime, benefits, etc.)	Maintenance for Processor @ 2% capital cost	DMV Wireline Communication DS0 from Data Loading	(see Common Equipment in Section 5.6)	Gov't. Admin. Wireline Communication DS1 from Data Loading	(see Common Equipment in Section 5.6)	Planning Subsystem Wireline Communication DS1 from	Data Loading (see Common Equipment in Section 5.6)	
	Mon-Recurring (Initial Capital Investment)											Recurring  (Operations & Maintenance)											

\* All prices are in thousands of 1995 dollars.

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### CV Safety Administration (CVA3)

Quantity	State *									State *									
Unit Price	Steady State *	20	20							Steady State	0.1								
Retail Price *		well		ects															
Comparative Technology		Per Loral, Rockwell	Exper. in similar	Integration Projects															
Quantity (High)	te *									te *									
Quantity (Low)	Introductory State *									Introductory State *									
Unit Price (High)	troduct	40	40							troduct	0.2								
Unit Price (Low)	ul	20	20							므	0.1								
Years to Replacement (Life Cycle)		20	20																
Equipment Description		Database Add-on	Software and Integration	Communication Line Included in CVA1	Note: Software is off-the-shelf technology and unit price does	not reflect product development.					Maintenance for addon processor @ 2% capital cost								
					ÐΛΙ	ınpe		iul)				(əɔu	ueue		გ s	iter	əd	0)	

\* All prices are in thousands of 1995 dollars.

### International CV Administration (CVA4)

International Database Management Add-on	(Life Cycle)	(Low)	(High)	(Low) (High)	h) Technology	Ketall Price	Unit Price	Quantity
International Database Management Add-on		Intr	Introductory State *	, State *			Steady State *	tate *
A -1-1:1: D	20	20	40		Per Loral, Roc	Per Loral, Rockwell Exper. in	20	
Additional Processing and Integration	20	20	40		similar Interation Projects	on Projects	20	
Additional Communication Wireline (International) DS0	20	0.5	-		Existing Technology	yology	0.5	
Note : Software is off-the-shelf technology and unit price does								
not reflect product development.								
		Intr	Introductory State	State *			Steady State	tate *
Additional Staff (2 at \$75,000 average)		135	165				135	
Note: Salary Costs are fully loaded prices (Base Salary,								
Overtime, Overhead, Benefits, etc.)								
Wireline Communication DS0 from Data Loading					Current Price Structure	Structure		
(see Common Equipment in Section 5.6)		9.0	1.2		from GTE		9.0	

FIGURE 4.6.1-4 INTERNATIONAL CV ADMINISTRATION, (CVA4)

### **4.6.2.** Commercial Vehicle Check Subsystem (CVCS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Citation and Accident Electronic Recording	(CVC1)
International Border Crossing	(CVC2)
Roadside Electronic Screening	(CVC3)
Roadside Safety Inspection	(CVC4)
Roadside WIM	(CVC5)

Each Equipment Package is described below.

### 4.6.2.1 Citation and Accident Electronic Recording, (CVC1)

The Equipment Package documents violations and forwards the information to the Commercial vehicle if available and to the CVAS for processing as part of the normal credentials processing package

This package utilizes additional roadside beacons for wireless transmission to the vehicles for recording of information onto the vehicle itself. This beacon is not included in the roadside subsystem as it is specifically dedicated to this package, subsystem, and stakeholder. Additionally, there is the need for a direct wireline connection to the roadside beacon from the CVC facility. This package has as a prerequisite Equipment Package the base equipment in CVC3.

### 4.6.2.2 International Border Crossing, (CVC2)

This Equipment Package is used by government agencies such as customs and immigration to check compliance with import/export and immigration regulations to allow release of cargo, vehicle, and driver across an international border.

This Equipment Package provides the Commercial Vehicle Inspection Subsystem the capabilities for two-way communication with approaching properly equipped commercial vehicles at mainline speeds, reading tags for automated vehicle identification and credential checking.

Due to the potential for independent operation of international facilities from domestic CVC's, this package is similar in equipment to the CVC3 package.

### 4.6.2.3 Roadside Electronic Screening, (CVC3)

This Equipment Package provides the Commercial Vehicle Check Subsystem the capabilities for two-way communication with approaching properly equipped commercial vehicles at

mainline speeds, reading tags for automated vehicle identification and credential checking. There is a capability to appropriately screen all vehicles, not just those that are equipped. This Equipment Package is able to process the data from the commercial vehicles along with accessed database information to determine whether a pull-in message is needed or to generate random pull-in messages with provisions for facility operators and enforcement officials to have manual override capabilities. Support is provided to both interstate and intrastate carriers.

Roadside beacons are used for roadside electronic screening application. This requires a two way beacon system with an interface to the roadside computer station. A vehicle detection system is required upstation. This system may be either installed on a tower or through portable devices.

An additional leased line or privately installed line is required to communicate to other centers. Some centers may require higher performance than other centers. Some centers may get by with dialup capability.

### 4.6.2.4 Roadside Safety Inspection, (CVC4)

This Equipment Package provides the Commercial Vehicle Check Subsystem the capabilities for operators to automate the roadside safety inspection process including the support of use of hand held devices to rapidly inspect the vehicle and driver. In addition this Equipment Package provides the Roadside Check Subsystem the capabilities for operators to automate the roadside safety inspection process including the support of automated mainline speed reading of on-board safety data to rapidly screen the vehicle and driver. This Equipment Package also provides the capabilities to collect, store, maintain, and provide safety data and access historical safety data after receiving identification from vehicles at mainline speeds or while stopped at the roadside. Results of screening and summary safety inspection can be written back onto the tag. The capabilities to process safety data and issue pull-in messages or provide warnings to the driver, carrier, and enforcement agencies are provided. These capabilities have a prerequisite of the Roadside Electronic Screening Equipment Package (CVC3) and are provided primarily through the utilization of an additional safety database.

Since a vehicle may cross jurisdiction boundaries during a trip, this Equipment Package supports the concept of a last clearance event record (a.k.a. trip ticket) carried on the vehicle's tag. The last clearance event record reflects the results of the roadside verification action. For example, if the vehicle is pulled over in State A and undergoes credential, weight, and safety checks, the results of the clearance process are written to the vehicle's tag. If the vehicle continues the trip and passes a roadside station in State B, the State B station has access to the results of the previous pull-in because it can read the last clearance event record written by the State A roadside station.

Handhold Safety Devices are utilized to inspect Commercial Vehicles. The devices either measure data themselves or read data from the vehicle. Safety Database Vehicle I/F is located in Roadside Facility. Wireline and wireless communications are required.

### 4.6.2.5 Roadside WIM, (CVC5)

This Equipment Package allows for roadside high speed weigh in motion. This package can be fixed to a location or mobile. It can include an interface to the credential check package and augment electronic credentials check with electronic weight check or it can be a stand alone package with display.

Specific equipment includes an interface to the roadside facility, and a WIM Fixed Load Cell.

# Citation and Accident Electronic Recording (CVC1)

Quantity	State *							State *									
Unit Price	Steady State *			20				Steady State		-		9.0					
Retail Price *				Per Loral, Rockwell exper. in	ation Projects						tructure						
Comparative Technology				Per Loral, Ro	similar Integration Projects						Current Price Structure	from GTE					
Quantity (High)	te *							te *									
Quantity (Low)	Introductory State *							Introductory State *									
Unit Price (High)	troduct			40				troduct		7		1.2					
Unit Price (Low)	In			70				'n		-		9.0					
Years to Replacement (Life Cycle)				20													
Equipment Description				Software Add-ons						Maintenance for Processor @ 5% of Capital Cost	CVAS Wireline Communication DS0 from Data Loading	(see Common Equipment in Section 5.6)					
		(ţu	rring ivest	սլլ		sitin	I)		1		ıəşu	вM	noe 8 &	iter	əd(	0)	

\* All prices are in thousands of 1995 dollars.

### International Border Crossing (CVC2)

Quantity	State *														State *										
Unit Price	Steady State	09	10	20		2	180	15		0.5	5			10	Steady State			9	2	2.5	0.3	3.6	_	0.5	
Retail Price *		ent and Advan.	Costs					Typical Operator Interface		ology		nology		nology			durchire								
Comparative Technology		Ref. Help Cresent and Advan.	I-75 Installation Costs				<b>&gt;</b>	Typical Opera	Workstation	Existing Technology	Ref. Seimens	Beacon Technology	Ref. Seimens	Beacon Technology			Current Price Structure	from GTE	) 						
Quantity (High)	*													_	*										
Quantity (Low)	Introductory State *														Introductory State										
Unit Price (High)	troduct	22	15	75		10	215	30		_	80			20	troduct			10	7.	3.8	0.5	4.3	1.5	0.8	
Prio (Low	드	20	10	20		2	180	15		0.5	2			10	u			9	2	2.5	0.3	3.6	-	0.5	
Years to Replacement (Life Cycle)		10	10	20		20	20	10		20	10			20											
Equipment Description		Commercial Vehicle Detection System	Roadside Signal Board	Roadside Structure - Mainline w/ Lane Indicator Signals	IIIS	Signal Indicator System	Software and Processor and Integration	Workstations (3)		Communication Line DS0 to International CVA Signals	Roadside Beacon (not included in Roadside Subsystem)	1	Dedicated Wireline Communication from Beacon to Roadside	(1 mile upstation)		(a)	International CVAS Wireline Communication DS0 from Data   pading	(see Common Equipment in Section 5.6)		Maintenance for Detection System @ 5% of Capital Cost	_	_	Maintenance for Signal Board @ 10% of Capital Cost	Beacon Repair/Replacement Maintenance @ 10% of Capital Cost	
			(1	uəı				9A- stic			init	)				(əɔ	ugu		ring Naii			ite.	ıəd	0)	

\* All prices are in thousands of 1995 dollars.

### Roadside Electronic Screening (CVC3)

Quantity	State *														State *											
Unit Price	Steady State	09	10	20		2	180	15		0.5	5			10	Steady State					9.0	2.5	0.3	3.6	_	0.5	
Retail Price *		ent and Advan.	Costs					Fypical Operator Interface		ology		nology		nology					tructure							
Comparative Technology		Ref. Help Cresent and Advan.	I-75 Installation Costs				<b>&gt;</b>	Typical Opera	Workstation	Existing Technology	Ref. Seimens	Beacon Technology	Ref. Seimens	Beacon Technology					Current Price Structure	from GTE						
Quantity (High)	* *							•			_	_	_	_	*											
Quantity (Low)	Introductory State *														Introductory State	1										
Unit Price (High)	troduc	75	15	75		10	215	30		-	∞			20	troduc					1.2	3.8	0.5	4.3	1.5	0.8	
Prio (Low	=	20	9	20		2	180	15		0.5	2			10	_					9.0	2.5	0.3	3.6	-	0.5	
Years to Replacement (Life Cycle)		10	10	20		20	20	10		20	10			20												
Equipment Description		Commercial Vehicle Detection System	Roadside Signal Board	Roadside Structure - Mainline w/ Lane Indicator Signals	IIIS	Signal Indicator System	Software and Processor and Integration	Workstations (3)		Communication Line DS0 to CVA Signals	Roadside Beacon (not included in Roadside Subsystem)		Dedicated Wireline Communication from Beacon to Roadside	(1 mile upstation)			(a	OHE.	CVAS Wireline Communication DS0 from Data Loading	(see Common Equipment in Section 5.6)	Maintenance for Detection System @ 5% of Capital Cost	_	_	Maintenance for Signal Board @ 10% of Capital Cost	Beacon Repair/Replacement Maintenance @ 10% of Capital Cost	
			(1	uəı				9A- stic			1inl	)					(ә	oue	euə		curr 8.8.N		ite.	ıəd	0)	

\* All prices are in thousands of 1995 dollars.

### Roadside Safety Inspection (CVC4)

	State *												State *										
Unit Price	Steady State	3	0.5	0.5	20		20						Steady State				1.2	0.3	0.8				
Retail Price *			ology		well Exper. in	n Projects	ckwell Exper.	eration								tructure							
Comparative Technology		Estimate	Existing Technology		Per Loral, Rockwell Exper. in	similar Interation Projects	Per Loral, Rockwell Exper.	In similar Interation	Projects							Current Price Structure	from GTE						
Quantity (High)	te *												, *										
Quantity (Low)	Introductory State *												Introductory State *										
Unit Price (High)	troduct	2	-	-	40		40						troduct				1.8	0.5	1.6				
Unii Prio	п	3	0.5	0.5	20		20						п				1.2	0.3	0.8				
Years to Replacement (Life Cycle)		2	20	20	20		20																
Equipment Description		Handheld Safety Devices (3 per location)	Vehicle I/F (located in Roadside Facility)	Wireless Communication to/from Facility to Handheld Device	Safety Database Add-on		Result Writing to Vehicle Tag Processor Add-on							No Additional Staff		Wireless Communication High from Data Loading	(see Common Equipment in Section 5.6)	Maintenance for Hand-held Devices @ 10% of Capital Cost	Maintenance for Processor @ 2% of Capital Cost				
					mjs		ul li ino:			1iu	ı)				- 1 -		uəju	_	8 :	its.	ıəd	0)	

\* All prices are in thousands of 1995 dollars.

### Roadside WIM (CVC5)

Quantity	State *									State *									
Unit Price	Steady State	10				4	-			Steady State	1	0.1	0.1						
Retail Price *		Prices				Prices	or Prices												
Comparative Technology		Current Vendor Prices				Current Vendor Prices	Current Vendor Prices												
Quantity (High)	ite *									te *									
Quantity (Low)	Introductory State *									Introductory State									
Unit Price (High)	troduc	15				9	7			troduc	1.5	0.1	0.2						
Unit Price (Low)	ч	10				4	-			드	-	0.1	0.1						
Years to Replacement (Life Cycle)		10				10	10			-									
Equipment Description		WIM - Load Cell - Fixed ( Software Included)	Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Interface to Roadside facility	Wireline Communication (Local Line)				Maintenance and Testing WIM Load Cell (10%)	Maintenance for Processor / IF @ 2% of Capital Cost	Maintenance for Comm. Line @ 10% of Capital Cost						
					mis	θΛι		N Isiti	uĮ)			 (əɔuɐ		gnir nisM		rat	ədc	<b>)</b>	

\* All prices are in thousands of 1995 dollars.

### **4.6.3** Commercial Vehicle Subsystem (CVS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
On-board Cargo Monitoring	(CVS1)
On-board CV Electronic Data	(CVS2)
On-board CV Safety	(CVS3)
On-board Trip Monitoring	(CVS4)

Each Equipment Package is described below.

### 4.6.3.1 On-board Cargo Monitoring, (CVS1)

This Equipment Package provides the Commercial Vehicle Subsystem the capability to monitor both interstate and intrastate cargo safety such that enforcement and HAZMAT response teams can be provided with timely and accurate information. This includes only the equipment on board the cargo container such as a communication device, possibly the addition of a cell-based radio, and equipment for the processing and storage of cargo material. This can also include optional sensors for temperature, pressure, load leveling, or acceleration depending upon the items monitored. It is already expected that the location devices such as GPS equipment and an integration processor already exist on the vehicle. These items are presented as part of the On-board Trip Monitoring Equipment Package (CVS4).

Cell based phones with digital capability are utilized for wide area wireless communications. In-vehicle processor and storage device are used for basic monitoring and other add-ons. In-vehicle sensors are utilized for various monitoring activities, including - temperature, load level gages, pressure gages, etc.

### 4.6.3.2 On-board CV Electronic Data, (CVS2)

This Equipment Package provides the Commercial Vehicle Subsystem the capability for two-way data exchange between the vehicle and the roadside facility with the transmission of information such as status of driver, vehicle, and carrier IDs and cargo information. The driver, vehicle and carrier are identified via the tag so that actual weight from roadside mainline weigh-in-motion may be checked. This includes only the equipment on the commercial vehicle including a processor/tag for identification, especially a HAZMAT identification. The actual reading and processing required for the credential checking and weigh-in-motion is performed by the roadside.

This Equipment Package may exist separately from CVS1 and CVS4 or be provided as an upgrade or add-on. The unit prices utilized here are reflective of separate systems. Marginal cost savings may be obtained by combining processors and software with add-on capability.

In-Vehicle software is required to provide entry of clearance numbers and interface to roadside. This could be as simple as a fixed ROM, numeric key pad, or on-board computer. A vehicle identification tag is also included, along with wireless communication devices similar to those of CVS1

### 4.6.3.3 On-board CV Safety, (CVS3)

This Equipment Package provides the Commercial Vehicle Subsystem the capability to collect and process on board vehicle and driver safety information to monitor the safety status and supply this information to the roadside facilities both at mainline speeds and while stopped for inspections. The capability to alert the commercial vehicle driver whenever there is a critical safety problem or potential emergency is also provided. These capabilities include only the equipment on the commercial vehicle including the sensors and processors to monitor the vehicle and driver with the information stored on the vehicle. When the information is transmitted to the roadside facility or after the trip, it utilizes the communication devices already in place. The package also supports onboard driver safety log maintenance and checking.

This Equipment Package builds upon the existence of either CVS1 or CVS4 or both. The equipment used for wireless communication and the software and processor for these previous Equipment Packages may be utilized with slight modifications or add-ons. The software for this Equipment Package is to assimilate all safety sensor inputs and flag warnings for unsafe conditions. Also, the software contains an interface to an active tag for transmitting the safety information to the roadside beacon(s).

### 4.6.3.4 On-board Trip Monitoring, (CVS4)

This Equipment Package provides the Vehicle Subsystem the capabilities to support fleet management with automatic vehicle location and automated mileage and fuel reporting and auditing. This package may also record other special events resulting from communication with roadside equipment. This includes only the equipment on board the vehicle to support this function including the vehicle location devices such as GPS equipment, communication interfaces, a processor to record trip length, and the sensors/actuators/interfaces necessary to record mileage and fuel usage.

The equipment used for wireless communication and the software and processor for the CVS1 Equipment Package may be utilized with slight modifications or add-ons. The software for this Equipment Package is to assimilate all vehicle location sensors, relying on GPS or DGPS. Additional assimilation is for trip computer mileage sensors and fuel reporting sensors.

### On-board Cargo Monitoring (CVS1)

Quantity	State *								,											
Unit Price	Steady State	0.3				0.02	90.0	0.1	3	Steady State		1.2		0.01	0.02					
Retail Price *		ology				nology	ology	ology			tructure									
Comparative Technology		Existing Technology				Existing Technology	Existing Technology	Existing Technology			Current Price Structure	from GTE								
Quantity (High)	te *									te °										
Quantity (Low)	Introductory State *								ď	Introductory State "										
Unit Price (High)	troduci	0.5				0.05	0.1	0.2		troduci		1.8		0.01	0.04					
Unit Price (Low)	드	0.3				0.02	0.05	0.1	-	=		1.2		0.01	0.02					
Years to Replacement (Life Cycle)		10				10	10	10		c										
Equipment Description		On-Board Processor & Storage	Note: Software is off-the-shelf technology and unit price does	not reflect product development.		On-Board Sensors - Temperature	Pressure Gauges	Load Level Gauges			Wireless Communication High from Data Loading	(see Common Equipment in Section 5.6)		Maintenance for Processor @ 2% of Capital Cost	Maintenance for Gauges @ 10% of Capital Cost					
		(1	uəi		currii I Inve					_	_	(əɔu	เธทล			Reci	ber	0)	_	_

\* All prices are in thousands of 1995 dollars.

### On-board CV Electronic Data (CVS2)

sing 10 0.05 0.1 Estimate 0.05 0.1 Similar Interaction Projects 0.03 octobrology and unit price does 10 0.3 0.5 similar Interaction Projects 0.3 octobrology and unit price does 10 0.3 0.5 similar Interaction Projects 0.3 octobrology and unit price does 10 0.3 octobrology and unit price does	Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Qué Price (L (High)	Quantity Quantity (Low) (High)	tity Comparative h) Technology	Retail Price *	Unit Price	Quantity
10			Intr	oductory	State *		i.	Steady 3	tate *
price does  10 0.3 0.5 similar Interation Projects 0.3 price does  Per Loral, Rockwell Exper. in 0.3 price does  Introductory State*  Capital Cost 0.01 0.02 current Price Structure  Capital Cost 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.0		10	0.05	0.1		Estimate		0.05	
price does         10         0.3         0.5         similar Interation Projects         0.3           price does         1	Additional Software and Processing	10	0.3	0.5		Per Loral, Roc	kwell Exper. in	0.3	
price does         Introductory State *         Steady State           Capital Cost         0.01         0.02         from GTE         0.01		10	0.3	0.5		similar Interation	on Projects	0.3	
Introductory State	Note: Software is off-the-shelf technology and unit price does								
Introductory State	not reflect product development.								
Introductory State *   Steady State   Current Price Structure   0.18   0.2   from GTE   0.01   0.0									
Introductory State *   Steady State   Steady State   Current Price Structure   0.18   0.2   from GTE   0.01   0.									
Introductory State *   Steady State   Steady State   Current Price Structure   0.18   0.2   from GTE   0.01   0.02     0.01									
Introductory State *   Steady State									
Introductory State *   Steady State   Steady Stat									
Introductory State *   Steady State   Steady State   Steady State   Current Price Structure									
Of Capital Cost 0.01 0.02 from GTE 1.001 0.02 from GTE 1.001 0.001 0.002 from GTE 1.001 0.001 0.002 from GTE 1.001 0.001			_ lut	oductory				Steady 8	
of Capital Cost 0.01 0.02 from GTE	Wireless Communication Low from Data Loading			<b>\</b>		Current Price \$	Structure		
@ 2% of Capital Cost 0.01 0.02	Equipment in Section 5.6)		0.18	0.2		from GTE		0.18	
	2% of		0.01	0.02				0.01	

FIGURE 4.6.3-2 ON-BOARD CV ELECTRONIC DATA, (CVS2)

### On-board CV Safety (CVS3)

	Quantity	State *													State *										
	Unit Price	Steady State	9.0					0.3	0	7.0	0.4				Steady State	0.01	0.01	0.02							
	Retail Price *		well Exper. in	n Projects			well Exper. in	ion Projects																	
	Comparative Technology		Per Loral, Rockwell Exper. in	similar Interation Projects			Per Loral, Rockwell Exper. in	similar Interation Projects	- Cotimoto	Latillate	Estimate														
	Quantity (High)	te *													te *										
	Quantity (Low)	Introductory State *													Introductory State *										
1	Unit Price (High)	troduct	1					0.5	2	t.	0.8				troduct	0.02	0.01	0.04							
2	Unit Price (Low)	'n	0.5					0.3	c	7.7	4.0				<b>l</b>	0.01	0.01	0.02							
>	rears to Replacement (Life Cycle)		10					10	6	2 !	10														
	Equipment Description		Additional Software and Processor for Warning Indicator and	Audio System Interface	Note: Software is off-the-shelf technology and unit price does	not reflect product development.	200	Data Storage	Control of		On-board Sensors - Driver					Maintenance for Processor @ 2% of Capital Cost	Maintenance for Data Storage @ 2% of Capital Cost	Maintenance for Sensors @ 5%	ni a	PIAI	200	9111	her		
				(1	uə				aR-no Stiqs			iul)	)				(ә	oue	euə		no:	its.	ıəd	0)	

\* All prices are in thousands of 1995 dollars.

### On-board Trip Monitoring (CVS4)

Quantity	State *												State *										
Unit Price	Steady State	1	0.25	0.3		0.1			74.0	5			Steady State	0.01	0.02	900.0	0.01		0.18				
Retail Price *				tructure	orld)	ology	Comparable to 286 CPU		, in (	(6)								tructure					
Comparative Technology				Current Price Structure	(Ref. GPS World)	Existing Technology	Comparable		T soitein									Current Price Structure	from GTE				
Quantity (High)	ite *												te *										
Quantity (Low)	Introductory State *												Introductory State										
Unit Price (High)	troduc	2	0.5	0.5		0.15			200	3			troduc	0.01	0.03	0.01	0.01		0.2				
Unit Price (Low)	и	1	10 0.03 it price does Cost 10 0.01 Cost 0.00 0.00																				
Years to Replacement (Life Cycle)		10																					
Equipment Description		Commercial Vehicle Communications Interface	Mileage and Fuel Reporting Sensors	GPS		Trip Computer and Processor	Note: Software is off-the-shelf technology and unit price does	not reflect product development.	Sibral boood Ilon on solitorius manage					Maintenance for Trip Computer @ 2% of Capital Cost	Maintenance for Sensors @ 5% of Capital Cost	Maintenance for GPS @ 2% of Capital Cost	Maintenance for Cell Radio @ 5% of Capital Cost	Wireless Communication Low from Data Loading	(see Common Equipment in Section 5.6)				
						·	uj ji	a Pines Sign	S) I		ıı)			<u>,</u>				<b>Ju</b> i	urrin § Ma		ber	0)	

\* All prices are in thousands of 1995 dollars.

### **4.6.4.** Emergency Management Subsystem (EM)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Emergency and Incident Management Communications	(EM1)
Emergency Mayday and E-911 Interface	(EM2)
Emergency Response Management	(EM3)
Emergency Vehicle Routing and Communications	(EM4)

Equipment Package is described below.

### 4.6.4.1 Emergency and Incident Management Communications, (EM1)

This Equipment Package provides a direct interface between emergency and incident management officials through shared databases and direct communications linkages. An example is the Computer Aided Dispatch (CAD) system used in California.

This Equipment Package relies on the initial deployment of the Emergency Response Management (EM3).

### 4.6.4.2 Emergency Mayday and E-911 Interface, (EM2)

This Equipment Package receives the MAYDAY data request from an in-vehicle unit and based on some criteria forwards the emergency message to the appropriate agency. The nature of the emergency is determined based on the information in the MAYDAY message as well as other inputs. This package is primarily an interface between automated MAYDAY calls and the E911 or Emergency Telephone Dispatch in the appropriate area.

This Equipment Package relies on the initial deployment of the Emergency Response Management (EM3). Additional equipment includes E-911 interface software and hardware as well as additional workstations.

### 4.6.4.3 Emergency Response Management, (EM3)

This Equipment Package provides the management of emergency response. It interfaces with emergency vehicles and other agencies/offices during an emergency and develops and stores emergency response plans. This Equipment Package provides emergency and MAYDAY management the capability to coordinate with multiple and other agencies before and during emergencies, to implement emergency response plans and track progress through the incident. Additionally, emergency management software is utilized with a workstation type processor. This Equipment Package also provides the capability to maintain the availability of emergency vehicle fleets and determine the best suited emergency vehicle to a particular emergency response.

The Emergency Response Management Equipment Package communicates with other ITS subsystems in order to receive information about emergencies and to convey recommended actions to appropriate entities in the system. Each emergency management center is connected to the TMC through communication lines for which the flow of information is two ways. Each Emergency Management Center receives information from the TMC for emergency situations, and the TMC in turn receives information from each Emergency Management Center for traffic management, route guidance, and signal control.

Existing centers are fully staffed with trained personnel, and fully equipped with power supply, backup generators, software, processors, displays, keyboards, system operator interfaces, and wire and wireless communications systems. Dedicated wire communication systems are in-place for information transfer from the existing Transportation Management Center. The existing operations include standard emergency response center functions. It is assumed that the physical structure that houses the operations staff, maintenance personnel, and equipment is in-place. It is also assumed that the maintenance staff, emergency response vehicle operators, dispatchers and other operations staff are already in-place. Only the incremental expense of incorporating ITS functions and communications is included in the expense for the this subsystem.

Additional equipment includes two way radios for special emergency frequency access when commercial wide area wireless does not provide sufficient support during critical situations, and wide area cell based wireless phone with digital capability. Existing communication lines are assumed to be fully utilized for existing services. Additional wirelines are required, either leased line or privately installed lines, to connect other centers. Some centers may require higher performance than other centers. Some centers may get by with dialup capability, and a shared database with software (per site). Additional staff is necessary to input new and revised emergency response plans into software.

### 4.6.4.4 Emergency Vehicle Routing and Communications, (EM4)

This Equipment Package provides the ability to track emergency vehicles responding to an incident. It interfaces with emergency vehicles and other agencies/offices during an emergency. This Equipment Package provides emergency and MAYDAY management the capability to coordinate with multiple and other agencies before and during emergencies, to track and manage vehicles automatically using real-time traffic conditions and signal timing for best routes, and preplan and generate automated responses to emergencies and MAYDAY. These capabilities are provided by the support of communications such as 2-way radio, mobile satellite telephone, or private fiber optic cable using modems and telephones. Additionally, vehicle tracking software is utilized with a workstation type processor.

This Equipment Package is an add-on to the previous subsystem Equipment Packages. Additional communication include an existing short wave transceiver.

# Emergency and Incident Management Communication (EM1)

Quantity	State *										State *											
Unit Price	Steady State	3	5.	0.5	2						Steady State	2.5			4.8		0.05					
Retail Price *			7-1	1-2	10-20										tructure							
Comparative Technology		Cotimito	Lalliate	Estimate	Network Hosts										Current Price Structure	from GTE						
Quantity (High)	te *										te *											
Quantity (Low)	Introductory State *										Introductory State											
Unit Price (High)	ıtroduc	7	-	_	10						itroduc	2			8.4		0.1					
Unit Price (Low)	JI I	C	5	0.5	2						_	2.5			4.8		0.05					
Years to Replacement (Life Cycle)		7	2	20	20						_											
Equipment Description		Dotohoo O condition (not cite)	_	Direct Communication Links (per site)	Shared Database Software (per site)	Note . Software is off the sholl technology and unit price does	Note: Software 13 Oil-tile-silen teomogy and diffe	not reflect product development.				Shared Database Software Maintenance Contract	(est'd. \$10k/region split by 4 sites)	EM & T	Loading (see Common Equipment in Section 5.6)		Maintenance for Comm. Links @ 5% of Capital Cost					
			_	uļs	εολι	noes tal li	idi		uĮ)				(ә			aint	curri 8. M	suc	atic	DGL	0)	

<sup>\*</sup> All prices are in thousands of 1995 dollars.

### Emergency Mayday and E-911 I/F (EM2)

Quantity	State *													State *										
Unit Price	Steady State	20	70				15							Steady State		,	1.4	0.3	0.6					
Retail Price *																			ructure					
Comparative Technology		Data/Modem	transf. Protoc.	to ASCII	character set		Existing	Workstations	for Operator	Interfaces									Current Price Structure	from GTE				
Quantity (High)	te *													te *										
Quantity (Low)	Introductory State *													Introductory State										
Unit Price (High)	troduct	20	100				30							troduct		(	7	0.5	1.2					
Unit Price (Low)	드	20	70				15							ln In		,	1.4	0.3	9.0					
Years to Replacement (Life Cycle)		10	10				10																	
Equipment Description		Data Communication Translation Software	E-911 Interface Software & Processor	Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Workstation (3 total)								No Additional Staff			Maintenance for Workstation @ 2% of Capital Cost	E-911 & RTS Wireline Communications DS0 from Data	Loading (see Common Equipment in Section 5.6)				
		<u> </u>		_		rrin 1ve:	al lr				}iu	)						uəjı	ring Mair	8 8	its.	ıəd	0)	

\* All prices are in thousands of 1995 dollars.

### Emergency Response Management (EM3)

Years to Unit   Price   Pric	Quantity	state *											tate *										
Production   Prince   Prince	Unit Price	Steady S	0.5	0.5	25	40	10	15					Steady S		9.0	0.5	0.3	135					
Veans to   Price   P	Retail Price *		vell			acts		station						ructure									
Nears to   Unit   Unit   Chounty	Comparative Technology		Per Loral, Rock	Experience	in Similar	Integration Proje		Existing Work	for Operator	Interface				Current Price St	from GTE								
Years to University   Price   Price	Quantity (High)	*											*										
Years to University   Price   Price	Quantity (Low)	ory Sta											ory Sta	ì									
Years to University   Price   Price	Unit Price (High)	troduct	-	_	20	80	20	30					troduct		1.2	2.5	9.0	165					
2% Salary,		므	0.5	0.5	22	40	9	15					드		9.0	0.5	0.3	135					
	Years to Replacement (Life Cycle)		20	20	10	10	10	10															
	Equipment Description		Communication To / From TMC	I/F with Vehicles and Other Agencies	Emergency Response Plans Database	Vehicle Tracking Software	Real Time Traffic Coord.	Workstations (3 total)						Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)	e Management Contract (per site)	Workstation & Computer Maintenance (per site) 2%		Note : Salary Costs are fully loaded prices (Base Salary,	Overhead, Benefits,			

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.4-3 EMERGENCY RESPONSE MANAGEMENT, (EM3)

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# Emergency Vehicle Routing and communications (EM4)

Quantity	State *								State *												
Unit Price	Steady State	0.5	0.2	0.2					Steady State			9.0			9.0				0.02		
Retail Price *		1-2	0.08-1	0.08-1								tructure			tructure						
Comparative Technology		Estimate	Voice Radios	Radios								Current Price Structure	from GTE		Current Price Structure	from GTE					
Quantity (High)	*								*												
Quantity (Low)	Introductory State *								Introductory State												
Unit Price (High)	troduct	1	-	_					troduct			1.2			1.2				0.1		
Unit Price (Low)	2	0.5	0.2	0.2					Ē			9.0			9.0				0.02		
Years to Replacement (Life Cycle)		20	2	22																	
Equipment Description		Communication from Center to TMC & Coordinating Agencies	Cell Based Radio (per radio)	2-way Radio (per radio)						Communication from Center to TMC	Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)	Communication from Center to ISP & FMS	Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)		Note: No additional staff		Maintenance for Radios @ 5% of Capital Cost		
				misə	ecurr Al Inv		sitia	1)		<u>.                                    </u>				ļui	вM		suo	iter	iəd(	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.4-4 EMERGENCY VEHICLE ROUTING AND COMMUNICATIONS, (EM4)

### **4.6.5** Emissions Management Subsystem (EMMS)

This subsystem contains only one Equipment Package, Emissions and Environmental Data Management (EMM1). This Equipment Package assimilates and stores the roadside collected environmental data, including emissions and environmental hazards such as icy road conditions and fog. Emissions data are stored and analyzed for evaluation and planning purposes. Environmental hazardous conditions are disseminated through CMS/HAR, etc.

Typical equipment for the Equipment Package is described below. Additional equipment to service these functions are included in the Roadside Subsystem. The Equipment Package is separated into two distinct functions, one for emissions management for localized detection and one for environmental hazards indicators.

The emissions management portion of the Equipment Package monitors and detects localized emissions levels for various contaminants per the EPA regulations. The identified devices for monitoring are included for all four measured contaminants. Non-attainment designated areas may wish to deploy only those sensors which may be required to monitor and detect the specific area(s) of non-attainment. The sensor information is stored in a local database for future analysis. Wireline communication capabilities are included for direct feed of emissions data to the Traffic Management Center for travel demand and other mitigating measures including congestion pricing and rideshare and HOV coordination.

The environmental hazards portion of the Equipment Package concentrate on the current weather conditions which contribute to environmental hazards, such as fog, and icing. Environmental hazard stations are anticipated to be located upstation from those areas which have histories of hazardous conditions. The number of locations is determined in the Evaluatory Design Document.

Specific equipment is outlined in the worksheet. Rather than include staff and equipment inventory specific for these limited devices, it is anticipated that annual contracts are a more economical method for these operation and maintenance requirements.

# Emissions and Environmental Data Management (EMM1)

se Quantity	Steady State *														Steady State *													
Unit Price	Stead		0.5												Stead	3	2	7	15	10	က	2	2			9.0		
Retail Price *																stallations	ew England	BA								Strucure		
Comparative Technology																Existing Site Installations	prices from New England	projects per LBA				<b>N</b>				Current Price Strucure	from GTE	
Quantity (High)	ite *														ite *													
Quantity (Low)	Introductory State *														tory Sta													
Unit Price (High)	ıtroduc		20 0.5 1																									
Unit Price (Low)	_																											
Years to Replacement (Life Cycle)			ging																									
Equipment Description		Equipment Costs are identified in Roadside Subsystem	Communication Line DS0 to PS,RS,TMS													Emissions Sampling & Analysis Contract	Emissions Maintenance Contract	Emissions Data Management	Emissions Quality Assurance	Environmental Sampling & Analysis Contract	Environmental Maintenance Contract	Environmental Data Management	Environmental Quality Assurance		Wireline Communication DS0 from Data Loading	(see Common Equipment in Section 5.6)		
			(1	uət		rrin 1ve					inl	)					(ə	our	uə			no:		iter	əd	0)		

\* All prices are in thousands of 1995 dollars.

### **4.6.6.** Emergency Vehicle Subsystem (EVS)

This subsystem contains the following Equipment Packages:

### Equipment Package Name On-board EV Incident Management Communication On-board Vehicle Signal Coordination (EVS1) (EVS2)

Each Equipment Package is described below.

### 4.6.6.1 On-board EV Incident Management Communication, EVS1)

This Equipment Package provides a direct interface between the emergency vehicle and incident management personnel. This communication is through existing emergency vehicle communication devices. The additional ITS related component of this communication is located at the incident management facility.

The communication occurs at the time of dispatch and throughout the incident occurrence. Information transmitted includes incident description, coordination activities among response vehicles and progress/completion of incident. This Equipment Package may be independent of EVS2.

### 4.6.6.2 On-board Vehicle Signal Coordination, (EVS2)

This Equipment Package provides the capability for vehicles to request signal priority or preemption, through communication either to the roadside or to the traffic management center. This Equipment Package is independent of EVS1. Typical equipment includes AVL capacity, data transceiver, and a separate transceiver to roadside signal systems.

# On-board EV Incident Management Communication (EVS1)

Quantity	State *									State *									
Unit Price	Steady State *	1	0.15							Steady State *	0.18			0.01					
Retail Price *											Structure								
Comparative Technology			Current	Voice Radios	0.1-1.0						Current Pricing Structure	from (GTE)							
Quantity (High)	te *									te *									
Quantity (Low)	Introductory State *									Introductory State *									
Unit Price (High)	troduct	2	0.26							troduct	0.2			0.01					
Unit Price (Low)	п	1	0.15							п	0.18			0.01					
Years to Replacement (Life Cycle)		10	10																
Equipment Description		EV Communication Interface	Cell Based Radio				Nac				Communication Low Use Bracket	(See Common Communication costs, Section 5.6)	Allocating 10% extra for higher unit price	Cell Based Radio Maintenance (5% Capital Cost)					
			(1	uəı			Non Sar	l Isijin	(II)			(ə:	nanc		urrin s Ma		Decr	<b>)</b>	

FIGURE 4.6.6-1 ON-BOARD EV INCIDENT MANAGEMENT COMMUNICATION, (EVS1)

\* All prices are in thousands of 1995 dollars.

## On-board Vehicle Signal Coordination (EVS2)

Quantity	State *												State *									
Unit Price	Steady State	6.0	0.15		0.5								Steady State	0.18		0.01	0.01	0.01				
Retail Price *														tructure								
Comparative Technology			Current Voice	Radios (0.1-1.0)	Current Price	Structures	(ref. GPS	World)						Current Price Structure	from GTE							
Quantity (High)	te *												* at									
Quantity (Low)	Introductory State *												Introductory State *									
Unit Price (High)	troduct	0.3	0.25		8.0								troduct	0.2		0.01	0.01	0.02				
Pric (Lov	ul	0.3	0.15		0.5								드	0.18		0.01	0.01	0.01				
Years to Replacement (Life Cycle)		10	10		10																	
Equipment Description		On Board Processor System	, Cell Based Radio (Data Transceiver Capability)		GPS/DGPS		Note: Software is off-the-shelf technology and unit price does not	reflect product development						CommWireless Low Use (see Common Equipment in Section 5.6)	assumes 10% excess of plan for high unit price	Maintenance for Processor @ 2% Capital Cost						
-				uə	mjs		սլլ	stiq	lon Cal	/ lsit	iul	)				ueuə	ļui	вM	าวอง	bera	lo)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.6-2 ON-BOARD VEHICLE SIGNAL COORDINATION, (EVS2)

### **4.6.7.** Fleet Management Subsystem (FMS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Fleet Administration	(FMS1)
Fleet Credentials and Taxes Management and Reporting	(FMS2)
Fleet HAZMAT Management	(FMS3)
Fleet Maintenance Management	(FMS5)
Freight Administration and Management	(FMS4)

Functions performed by Commercial Fleet Management include: Vehicle pre-clearance, vehicle administration, and on-board safety monitoring. To perform these functions, communications links are required to various other subsystems and Equipment Packages in the ITS architecture. Examples of communications requirements are: FMC to vehicles in transit and the drivers, FMC to CVO fleet managers, FMC to government agencies, and FMC to financial clearinghouse(s).

It is assumed that the physical structure that houses the FMC operations staff, maintenance personnel, and equipment is in-place. Although the building infrastructure is assumed in-place, as well as some operations staff, maintenance personnel, and equipment, there are some components to the subsystem which are either upgrades, or additions to the existing operations. These incremental expenses are attributed to the ITS architecture expense.

There is minimal expense for ITS trained operations and maintenance staff and related equipment included in recurring expenditures. Many of the existing commercial fleet management centers throughout the US are currently staffed with trained controllers, supervisors and maintenance personnel. The minimal amount expenditures for training are explicitly noted in the recurring expenditures.

Each Equipment Package is described below.

### 4.6.7.1 Fleet Administration, (FMS1)

This Equipment Package provides route plan information from the FMS to the TMS for network performance evaluation. It also provides for vehicle tracking, dispatch, and reporting to the fleet management center personnel.

### 4.6.7.2 Fleet Credentials and Taxes Management and Reporting, (FMS2)

This Equipment Package provides the Fleet Management Subsystem the capabilities to purchase credentials and file trip reports electronically by the fleet managers, to perform automated preclearance at the roadside facilities, and electronically manage the credentials checking by the roadside commercial vehicle inspectors. The electronic purchase is performed in accordance with developing standards such that a single integrated system for

electronic payments might develop ensuring that deployment across multiple agency political boundaries is performed without degradation. Inherent to credential management is the management of the vehicles, with a prerequisite of the vehicle tracking software from the Fleet Administration Equipment Package (FMS1).

Add-on software and databases are included as well as additional workstations and wireless communication capability for transmission of information to and from the fleet.

### 4.6.7.3 Fleet HAZMAT Management, (FMS3)

This Equipment Package provides the Fleet Management Subsystem the capabilities to enhance the Fleet Administration Equipment Package functions by adding HAZMAT tracking. The additional requirements to perform this function include enhanced processing and enhanced fleet management software. In order to effectively track HAZMAT cargo, communication interfaces to Information Service Providers, Emergency Management, and Traffic Management Subsystems are provided, including additional communication software.

### 4.6.7.4 Fleet Maintenance Management, (FMS5)

This Equipment Package provides the capability to use vehicle mileage data to automatically generate preventative maintenance schedules for each specific vehicle by utilizing vehicle tracking data from the prerequisite Fleet Administration Equipment Package. In addition, capability to automatically ensure that proper service personnel are provided information for maintenance activities and to record and verify that maintenance work was performed is provided. These capabilities are performed utilizing fleet management software.

### 4.6.7.5 Freight Administration and Management, (FMS4)

This Equipment Package provides the communication necessary to track cargo from source to destination via links to intermodal freight shippers and depots. There are also communication links to cargo routing services.

### Fleet Administration (FMS1)

Quantity	State *											State *									
Unit Price	Steady State	10	40	1.1	300	2						Steady State *	4		9.0		9.0				
Retail Price *		SI		well			ojects		ation					tructure		tructure					
Comparative Technology		Existing Systems		Per Loral, Rockwell	Experience	in Similar	Integration Projects		Existing Workstation	for Operator	Interface			Current Price Structure	from GTE	Current Price Structure	from GTE				
Quantity (High)	te *											*									
Quantity (Low)	Introductory State *											Introductory State *									
Unit Price (High)	troduct	15	100	က	200	9						troduct	10		1.2		1.2				
Unit Price (Low)	ㅁ	10	40	<u></u>	300	2						드	4		9.0		9.0				
Years to Replacement (Life Cycle)		20	20	5	20	10															
Equipment Description		Vehicle Location Interface	Vehicle Tracking and Scheduling	Digital Communication Device (3 per FMS)	System Integration	Workstations (1)		Note: Software is off-the-shelf technology and unit price does					Maintenance for Software @ 10% of Capital Cost	ISP/TMC Wireline Communication DS0 from Data		Payment Instrument Wireline Communication DS0 from Data					
					шţs	εeλί	uj ji ino:				inl)			(əɔu	euə	enir Main	8 8	rati	ədc	)	

FIGURE 4.6.7-1 FLEET ADMINISTRATION, (FMS1)

\* All prices are in thousands of 1995 dollars.

# Fleet Credentials and Taxes Management and Reporting (FMS2)

Quantity	State *													State *										
Unit Price	Steady State	9.0	20	40	20	215	15							Steady State	6.0		4 8	2	337					
Retail Price *		ologies	well			ects	station										tructure							
Comparative Technology		Existing Technologies	Per Loral, Rockwell	Experience	in Similar	Integration Projects	Existing Workstation	for Operator	Interface								Current Price Structure	from GTE						
Quantity (High)	te *													:e *										
Quantity (Low)	Introductory State *													Introductory State *										
Unit Price (High)	troduct	1	40	100	40	200	30							troduct	9.0		8 4	5	412					
Pric (Lov	<b>l</b>	0.5	20	40	70	215	15							п	0.3		4	2	337					
Years to Replacement (Life Cycle)		2	20	20	20	20	2																	
Equipment Description		Wireless Communication	Electronic Credential Purchase Software	Database and Management for Trip Reports	Database Management for Preclearance	Processor and Integration	-		Note: Software is off-the-shelf technology and unit price does	not reflect product development.					Maintenance for Workstations @ 2% of Capital Cost	Wireline Communication DS1 from Data			Additional Staff Salary and Benefits (5 @ 75k)		Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)		
			(1	uə			ul li				iul	)				(əɔı	ıeu			Recr & suc	atic	beı	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.7-2 FLEET CREDENTIALS AND TAXES MANAGEMENT AND REPORTING, (FMS2)

### Fleet HAZMAT Management (FMS3)

Quantity	State *									State *									_
Unit Price	Steady State	20	1.5	2						Steady State *	0.4	0.1		9.0					
Retail Price *			logy	ation										tructure					
Comparative Technology			Existing Technology	Existing Workstation	for Operator	Interface								Current Price Structure	from GTE				
Quantity (High)	te *									te *									
Quantity (Low)	Introductory State *									Introductory State *									
Unit Price (High)	troduct	40	3	10						troduct	8.0	0.2		1.2					
Unit Price (Low)	Int	20	1.5	2						In	0.4	0.1		9.0					
Years to Replacement (Life Cycle)		20	20	10						_									
Equipment Description		Vehicle Tracking and Scheduling Enhancement	Wirelines to ISP, ERMS & TMC (3 Total)	Workstation (1 Dedicated)		Note: Software is off-the-shelf technology and unit price does	not reflect product development.				Maintenance for Software @ 2% of Capital Cost	Maintenance for Workstation @ 2% of Capital Cost	EM Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)					
					шţs	ερλι	Recui Ital In		uĮ)		<u> </u>				urring k Maint	oits.	ber	<b>o</b> )	

FIGURE 4.6.7-3 FLEET HAZMAT MANAGEMENT, (FMS3)

\* All prices are in thousands of 1995 dollars.

### Fleet Maintenance Management (FMS5)

Quantity	State *									State *				
Unit Price	Steady State	100	20			2				Steady State *	2.4		4.8	
Retail Price *		well			ects	λοίοα	660						tructure	
Comparative Technology		Per Loral, Rockwell	Experience	in Similar	Integration Projects	Existing Technology							Current Price Structure	from GTE
Quantity (High)	te *									te *				
Quantity (Low)	Introductory State *									Introductory State *				
Unit Price (High)	troduct	200	40			~	-			troduct	4.8		8.4	
Unit Price (Low)	п	100	20			0				u	2.4		4.8	
Years to Replacement (Life Cycle)		20	20			20								
Equipment Description		Integration	Processor/Software Upgrades			Communication Lines DS1 to Maintenance Facility		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Maintenance for System @ 2% of Capital Cost	Wireline Communication DS1 from Data	Loading (see Common Equipment in Section 5.6)	
		_		uəı		əvul	oeR-no lstiqsC							Recurring Recurring & Mainto

FIGURE 4.6.7-4 FLEET MAINTENANCE MANAGEMENT, (FMS5)

\* All prices are in thousands of 1995 dollars.

## Freight Administration and Management (FMS4)

Unit Price Quantity	Steady State *							Steady State *		9.0		9.0				
Unit	Ste	1	7					Ste		0.		Ö				
Retail Price *									tructure		tructure					
Comparative Technology		<b>Current Prices</b>	<b>Current Prices</b>						Current Price Structure	from GTE	Current Price Structure	from GTE				
Quantity (High)	• *							*								
Quantity (Low)	Introductory State *							Introductory State								_
Unit Price (High)	roducto	2	2					roducto		1.2		1.2				
Unit Price (Low)	Inti	1	_					Ī		9.0		9.0				
Years to Replacement (Life Cycle)		10	10													
Equipment Description		Communication Interface to Intermodal Freight Depot	Communication Interface to Intermodal Freight Shipper						Freight Depot Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)	Freight Shipper Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)				
-		O		etmen 10	Pecu Ilalio	sitinl	)		<u>L</u>		eusu Gusu			erat	dO)	

FIGURE 4.6.7-5 FLEET ADMINISTRATION AND MANAGEMENT, (FMS4)

### **4.6.8.** Information Service Provider Subsystem (ISP)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Basic Information Broadcast	(ISP1)
EM Route Plan Information Dissemination	(ISP2)
Infrastructure Provided Dynamic Ridesharing	(ISP3)
Infrastructure Provided Route Selection	(ISP4)
Infrastructure Provided Yellow Pages & Reservation	(ISP5)
Interactive Infrastructure Information	(ISP6)
ISP Advanced Integrated Control Support	(ISP7)
ISP Probe Information Collection	(ISP8)

A description of these Equipment Packages is provided below.

### **4.6.8.1 Basic Information Broadcast, (ISP1)**

This Equipment Package provides the capabilities to collect, process, store, bill, and disseminate traveler information including traveler, transit, ridematching, traffic, and parking information. The traveler information includes maintaining a database of local area services available to travelers with up-to-the-minute information and providing an interactive connectivity between, sponsors, and providers of services. The transit information includes the latest available information on transit routes and schedules, transit transfer options, transit fares, and real-time schedule adherence. The traffic information includes latest available information on traffic and highway conditions, and current situation information in real-time including incidents, road construction, recommended routes, current speeds on specific routes, current parking conditions in key areas, schedules for any current or soon to start events, and current weather situations.

This Equipment Package also provides users with real-time travel related information while they are traveling, and disseminate the information to assist the travelers in making decisions about transfers and modification of trips. The Equipment Package is the first of the ISP Subsystem Equipment Packages. Further services rely on ISP1 equipment for a basis.

These capabilities are provided using equipment such as a fixed facility with dedicated network servers, workstations for each employee, map data bases, and a communications system such as a data subcarrier multiplexing device. Pricing includes the lease space of an FM Subcarrier.

### 4.6.8.2 EM Route Plan Information Dissemination, (ISP2)

This Equipment Package provides route plan information for the Emergency Management Subsystem. Routes are computed based on the requests for route plans and current traffic

conditions. This equipment package relies on ISP4, ISP6, and ISP1, for basic equipment and provides additional service with equipment add-ons.

### 4.6.8.3 Infrastructure Provided Dynamic Ridesharing, (ISP3)

This Equipment Package has as prerequisite the capabilities of the Interactive Infrastructure Information Equipment Package, ISP6, and Basic Information Broadcast Equipment Package, ISP1. In addition, this Equipment Package provides the capability to provide specific dynamic ridesharing, including rider and driver information and reservations.

Additional equipment includes additional workstations and communication lines. Also added is the expense of liability insurance (as identified in the legal and institutional evaluation activities in the Implementation Strategy Document.

### 4.6.8.4 Infrastructure Provided Route Selection, (ISP4)

This Equipment Package has as prerequisite the capabilities of the Interactive Infrastructure Information Equipment Package, ISP6 and Basic Information Broadcast Equipment Package, ISP1. In addition, this Equipment Package provides the capability to provide specific directions to travelers by receiving origin and destination requests from travelers, generating route plans, returning the calculated plans to the users, and then potentially logging the route plans with Traffic Management Subsystem. This additional capability is provided using additional equipment such as software for route planning and traffic measurements along with additional map data base upgrades.

### 4.6.8.5 Infrastructure Provided Yellow Pages & Reservation, (ISP5)

This Equipment Package has as prerequisite the capabilities of the Interactive Infrastructure Information Equipment Package, ISP6 and Basic Information Broadcast Equipment Package, ISP1. In addition, this Equipment Package provides the capability to provide specific traveler information, such as Yellow Pages information, with reservation capabilities. This capability is provided using additional equipment such as software for yellow pages database and reservation systems, additional staff and workstations along with additional communication lines.

### 4.6.8.6 Interactive Infrastructure Information, (ISP6)

This Equipment Package has as prerequisite the capabilities of the Basic Information Broadcast Equipment Package. This Equipment Package augments the Basic Information Broadcast Equipment Package by providing the capabilities for interactive traveler information. Required equipment includes additional workstations, and computer server, staff, trip planning software, and communication lines.

### **4.6.8.7 ISP Advanced Integrated Control Support, (ISP7)**

This Equipment Package supports the traffic management center provision of real-time optimized signal control by providing ISP route planning information. Prerequisite Equipment Packages include ISP8, ISP4, ISP6, and ISP1. This capability is provided utilizing system upgrades for hardware and software with additional communication lines.

### 4.6.8.8 ISP Probe Information Collection, (ISP8)

This Equipment Package supports the collection of vehicle probe data by the ISP. It provides the capability to accept and process probe vehicle information. This capability is provided through the use of additional hardware and probe vehicle control and tracking software.

### Basic Information Broadcast (ISP1)

	Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
			Int	roducto	Introductory State	*			Steady State	State *
	Two Processors (Servers)	2	27	33			Per Loral, Rockwell	well	27	
()	Workstations (5)	2	13.5	16.5			Experience in Similar	imilar	13.5	
uəW	Integration	20	06	110			Integration Projects	ects	06	
ring vest	Database Software	20	25	20			Per Loral, Rockwell	well	25	
	Traffic Analysis Software (includes some product development)	20	250	200			Experience in Similar	Similar	250	
		2	15	30			Integration Projects	ojects	15	
	Communication Lines DS1	20	0.5	-			Existing Technology	logy	0.5	
	Communication Lines DS0	20	0.5	-			Existing Technology	logy	0.5	
1in	Communication Lines DS0	20	0.5	-			Existing Technology	logy	0.5	
I <i>)</i>	Note: Software is off-the-shelf technology and unit price does									
	not reflect product development, unless noted otherwise.									
			<u>1</u>	roducto	Introductory State	*			Steady State *	State *
	Maintenance for Hardware Systems @ 2% of Capital Cost		0.81	0.99			Estimate		0.81	
(Ә	Maintenance for Software Systems @ 5% of Capital Cost		13.75	27.5			Estimate		13.75	
out	Wireline Communication DS1 from Data									
:uə	Loading (see Common Equipment in Section 5.6)		4.8	8.4			Current Price Structure	tructure	4.8	
	Wireline Communication DS0 from Data									
	Loading (see Common Equipment in Section 5.6)		9.0	1.2			Current Price Structure	tructure	9.0	
noe	Wireline Communication DS0 from Data									
	Loading (see Common Equipment in Section 5.6)		9.0	1.2			Current Price	Structure	9.0	
ite.	Staff (2@50K to 75K +1@75K to 100K)		175	250			Estimate		175	
iəd(	FM Subcarrier Lease (10 to 20K per month)		120	240			Estimate from Phase	Phase I	120	
)) 										
	Note: Salary Costs are fully loaded prices (Base Salary,									
	Overtime, Overhead, Benefits, etc.)									

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.8-1 BASIC INFORMATION BROADCAST, (ISP1)

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## EM Route Plan Information Dissemination (ISP2)

ce Quantity	Steady State *									Steady State *							
Unit Price	Stea	13.5		20						Stea	0.27	2.5					
Retail Price *		ılogy		well	Similar	ojects											
Comparative Technology		Existing Technology		Per Loral, Rockwell	Experience in Similar	Integration Projects					Estimate	Estimate					
Quantity (High)	te *									* *							
Quantity (Low)	Introductory State *									Introductory State							
Unit Price (High)	troduct	16.5		100						troduct	0.33	2					
Pric On	Int	13.5		20						In	0.27	2.5					
Years to Replacement (Life Cycle)		2		20													
Equipment Description		Processor (Server)		Route Guidance Software Upgrade (from ISP4)				Note : Software is off-the-shelf technology and unit price does	not reflect product development, unless noted otherwise.		Maintenance for Hardware Systems @ 2% of Capital Cost	Maintenance for Software Systems @ 5% of Capital Cost					
		[₾	tment)	sən	ul l	9A-r siiqi	ion tial Ca				≥		eua	curri & M	berat	0)	

FIGURE 4.6.8-2 EM ROUTE PLAN INFORMATION DISSEMINATION, (ISP2)

## Infrastructure Provided Dynamic Ridesharing (ISP3)

Years to   Unif   Unif   Quantity   Comparative   Retail Price * Unif   Unif   Unif   Quantity   Technology	Quantity	State *									State *										
Years to   Price   Price   Quantity   Quantity   Comparative   Retail Price   Liew   (High)   Technology	Unit Price	Steady State	5.4		100		0.5	0.5			Steady 5	0.108	2	20		9.0		9.0	100		
Years to   Unit   Choin   Price   Price   (Low)   (High)   (Life Cycle)   (Low)   (High)   (Low)   (High)   (Low)   (High)   (Low)   (High)   (Low)   (High)   (Life Cycle)   (Low)   (High)	Retail Price *		ology	well	Similar	ojects	ology	ology								tructure		Structure			
Years to   Unit   Unit   Quantity	Comparative Technology		Existing Techno	Per Loral, Rock	Experience in	Integration Pr	Existing Techno	Existing Techno				Estimate	Estimate	Estimate		Current Price S		Current Price	Estimate		
Priority Priority (Life Cycle) (Low (Life Cycle) (Low	Quantity (High)	te *									*										
Priority Priority (Life Cycle) (Low (Life Cycle) (Low	Quantity (Low)	tory Sta									tory Sta	•									
Priority Priority (Life Cycle) (Low (Life Cycle) (Low	Unit Price (High)	ıtroducı	9.9		200		_	_			troduct	0.132	10	100		1.2		1.2	150		
ent)	Unii Prio	In	5.4		100		0.5	0.5			드	0.108	2	20		9.0		9.0	100		
Equipment Description  Workstations (2 Additional)  Rideshare Pkg Software (includes some product development)  Rideshare Pkg Software (includes some product development)  Communication Lines DS0  Communication Lines DS0  Communication Lines DS0  Communication Lines DS0  Note: Software is off-the-shelf technology and unit price does not reflect product development, unless noted otherwise.  Maintenance for Hardware Systems @ 2% of Capital Cost Maintenance for Software Systems @ 5% of Capital Cost Liability Insurance (50 to 100K per Year)  Wireline Communication DS0 from Data  Loading (see Common Equipment in Section 5.6)  Staff (1@50 to 75K for two shifts)  Note: Salary Costs are fully loaded prices (Base Salary, Overhead, Benefits, etc.)	Years to Replacement (Life Cycle)		2		20		20	20													
(Operations & Maintenance) (Initial Capital Investment)	Equipment Description								Note: Software is off-the-shelf technology and unit	not reflect product development, unless noted otherwise.		Maintenance for Hardware Systems @ 2% of Capital Cost	Maintenance for Software Systems @		Wireline Communication DS0 from Data		-				

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.8-3 INFRASTRUCTURE PROVIDED DYNAMIC RIDESHARING, (ISP3)

### Infrastructure Provided Route Selection (ISP4)

Quantity	State *										State *								15 dollare
Unit Price	Steady State *			250		100					Steady State	12.5							cande of 190
Retail Price *				vell	Similar	ojects													* All prices are in thousands of 1005 dollars
Comparative Technology				Per Loral, Rockwell	Experience in Similar	Integration Projects						Estimate							*
Quantity (High)	te *										*								
Quantity (Low)	Introductory State *										Introductory State *								
Unit Price (High)	troduci			200		200					troduci	25							
Unit Price (Low)	드			250		100					드	12.5							
Years to Replacement (Life Cycle)	-			20		2													
Equipment Description				Route Selection Software		Map Database Software Upgrade			Note: Software is off-the-shelf technology and unit price does	not reflect product development, unless noted otherwise.		Maintenance for Software Systems @ 5% of Capital Cost							
		(jue	etme	ÐΛΙ		stiq	noM sO la	ițin					ueu		s su	ł atioi	ber	0)	

FIGURE 4.6.8-4 INFRASTRUCTURE PROVIDED ROUTE SELECTION, (ISP4)

# Infrastructure Provided Yellow Pages & Reservation (ISP5)

Properties   Pro										
Introductory State		Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)				Retail Price *	Unit Price	Quantity
Monkstations (2)   Software   Existing Technology   Workstations (2)   Software   Existing Technology   Monkstations (2)   Software   Existing Technology   Per Loral, Rockwell   Per Loral, Rockwel				Intr	oductory	State *			Steady	State *
Morkstations (2)   Workstations (2)   Workstation										
Automated Reservation Software  Automated Reservation Projects  Automated Reservation Reservation  Automated Reservation Projects  Automated Reservation Reservation  Automated Reservation Reservation  Automated Reservation Reservation  Automated Reservation Reservation  Automated Reservation  Automa	(ţuəi		2	5.4	9.9		Existing Techno	ology	5.4	
Yellow Pg DB Software (includes some product development)		Automated Reservation Software	20	100	200		Per Loral, Rock	well	100	
Communication Lines DS0 for Yellow Pages Providers   Communication Lines DS0 for Data   Cost   Capital Cost   Communication DS0 from Data   Cost   Capital Cost   Communication DS0 from Data   Communicati		Pg DB Software (includes some product dev	20	250	200		Experience in	Similar	250	
Communication Lines DS0 for Yellow Pages Providers 20 0.5 1 Existing Technology  Interest product development, unless noted otherwise.  Introductory State*  Maintenance for Hardware Systems © 2% of Capital Cost 17.5 35 Estimate  Maintenance for Software Systems © 5% of Capital Cost 17.5 35 Estimate  Maintenance for Software Systems © 5% of Capital Cost 17.5 35 Estimate  Maintenance for Software Systems © 5% of Capital Cost 17.5 35 Estimate  Maintenance for Software Systems © 5% of Capital Cost 17.5 35 Estimate  Maintenance for Hardware Systems © 5% of Capital Cost 17.5 35 Estimate  Maintenance for Hardware Systems © 5% of Capital Cost 17.5 35 Estimate  Maintenance for Hardware Systems © 5% of Capital Cost 17.5 35 Estimate  Maintenance for Hardware Systems © 5% of Capital Cost 17.5 35 Estimate  More: Salary Costs are fully loaded prices (Base Salary, Overtime, Overthead, Benefits, etc.)							Integration Pr	rojects		
Maintenance for Hardware Systems © 2% of Capital Cost Administranance for Software Systems © 5% of Capital Cost Administranance for		Communication Lines DS0 for Yellow Pages Providers	20	0.5	-		Existing Techno	ology	0.5	
Maintenance for Hardware Systems © 2% of Capital Cost   17.5   35   Estimate   Estimate   1.2   Current Price Structure   1.2   Structure	uĮ)	Software is off-the-shelf technology and unit								
Maintenance for Hardware Systems @ 2% of Capital Cost 0.108 0.132 Estimate  Maintenance for Software Systems @ 5% of Capital Cost 17.5 35 Estimate  Maintenance for Software Systems @ 5% of Capital Cost 17.5 35 Estimate  Wireline Communication DS0 from Data  Loading (see Common Equipment in Section 5.6) 0.6 1.2 Current Price Structure  Staff (1 @ 50 to 75K for two shifts) 100 150 Estimate  Overtime, Overhead, Benefits, etc.)		not reflect product development, unless noted otherwise.								
Maintenance for Hardware Systems @ 2% of Capital Cost  Maintenance for Software Systems @ 5% of Capital Cost  Maintenance				Intr	oductory	State *			Steady	State *
Maintenance for Software Systems @ 5% of Capital Cost 17.5 35 Estimate Estimate   17.5 35   Estimate   17.5 36 10 75K for two shifts   17.5		Maintenance for Hardware Systems @ 2% of Capital Cost		0.108	0.132		Estimate		0.108	
Wireline Communication DS0 from Data  Wireline Communication DS0 from Data  Loading (see Common Equipment in Section 5.6)  Loading (see Common Equipment in Section 5.6)  Loading (see Common Equipment in Section 5.6)  Staff (1@50 to 75K for two shifts)  Staff (1@50 to 75K for two shifts)  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)	(əɔut	Software Systems @		17.5	35		Estimate		17.5	
Loading (see Common Equipment in Section 5.6)  Start (1 @ 50 to 75K for two shifts)  Staff (1 @ 50 to 75K for two shifts)  Staff (1 @ 50 to 75K for two shifts)  Note: Salary Costs are fully loaded prices (Base Salary,  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)		Wireline Communication DS0 from Data								
Staff (1@50 to 75K for two shifts)		Loading (see Common Equipment in Section 5.6)		9.0	1.2		Current Price S	itructure	9.0	
Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)		CHaff (1 @ EO to 7EK for two chiffe)		5	7. CR		Totimoto		100	
	Opera	Stall (1@50 to 75N tol two stillts)		3	001		באוווומום		3	
Benefits,	)	Note: Salary Costs are fully loaded prices (Base Salary,								
		Benefits,								

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.8-5 INFRASTRUCTURE PROVIDED YELLOW PAGES & RESERVATION, (ISP5)

### Interactive Infrastructure Information (ISP6)

Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price Qui (High)	Quantity Quantity (Low)	y Comparative Technology	Retail Price *	Unit Price	Quantity
		Inf	Introductory State *	, State *			Steady State	tate *
Additional Processor (Server)	2	13.5	16.5		Per Loral, Rockwell	=	13.5	
Workstations (2)	5	5.4	9.9		Experience in Similar	ilar	5.4	
Integration	20	90	110		Integration Projects	S	06	
					Per Loral, Rockwell	=		
Trip Planning Software (includes some product development)	20	250	200		Experience in Similar	imilar	250	
:	;	1			Integration Projects	ects	1	
Communication Lines DS1	20	0.5	~		Existing Technology	gy	0.5	
Note: Software is off-the-shelf technology and unit price does								
	-	In	Introductory State	State *	-		Steady State	tate *
Maintenance for Hardware Systems @ 2% of Capital Cost		0.378	0.462		Estimate		0.378	
Maintenance for Software Systems @ 5% of Capital Cost		12.5	25		Estimate		12.5	
Loading (see Common Equipment in Section 5.6)		4.8	8.4		Current Price Structure	ıcture	4.8	
Wireline Communication DS0 from Data								
Staff (1@50K to 75K for two shifts)		100	150		Estimate		100	
Note: Colony (Doctor of the letter books)								
Overtime Overhead Benefite etc.)								
Overtime, Overnead, benefits, etc.)					_			

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.8-6 INTERACTIVE INFRASTRUCTURE INFORMATION, (ISP6)

### ISP Advanced Integrated Control Support (ISP7)

Additional DASD/ Processor Power		Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
Additional DASD/ Processor Power   5 25 50   10   Per Loral, Rockwell   25   26   26   26   26   26   26   26				Int	troducte	ory State	*			Steady	state *
Integration		Additional DASD/ Processor Power	5	25	20			Per Loral, Rock	well	25	
Automated Communications w/ TMC Software   20   100   200   200   Experience in Similar   100   200   200   Experience in Similar   100   200   200   200   Experience in Similar   100   200	(1							Experience in S	imilar		
Automated Communications w/ TMC Software   20   100   200   Per Loral, Rockwell   100	uew		20	06	110			Integration Proje	ects	06	
Communication Lines DS1			20	100	200			Per Loral, Rock	well	100	
Integration Lines DS1								Experience in	Similar		
Communication Lines DS1								Integration Pr	ojects		
Note: Software is off-the-shelf technology and unit price does   Note: Software is off-the-shelf technology and unit price does   Note: Software is off-the-shelf technology and unit price does   Note: Software Systems @ 2% of Capital Cost   Note: Software Systems @ 5% of Capital Cost		Communication Lines	20	0.5	-			Existing Techno	logy	0.5	
Maintenance for Hardware Systems @ 2% of Capital Cost	inl)	Note: Software is off-the-shelf technology and unit									
Maintenance for Hardware Systems @ 2% of Capital Cost											
Maintenance for Hardware Systems @ 2% of Capital Cost		not reflect product development, unless noted otherwise.									
Maintenance for Hardware Systems @ 2% of Capital Cost  Maintenance for Software Systems @ 5% of Capital Cost  Maintenance for Software Systems @ 5% of Capital Cost  Wireline Communication DS1 from Data  Loading (see Common Equipment in Section 5.6)  Maintenance for Software Systems @ 5% of Capital Cost  Wireline Communication DS1 from Data  Loading (see Common Equipment in Section 5.6)  Maintenance for Software Systems @ 2% of Capital Cost  Estimate  Estimate  Current Price Structure  Current Price Structure  Opportunity  Opportunit				II.	troducte	ory Stat				Steady	
Maintenance for Software Systems © 5% of Capital Cost  Mireline Communication DS1 from Data  Loading (see Common Equipment in Section 5.6)  A.8 8.4 Current Price Structure  Courrent Price Structure		@		0.5	1			Estimate		9.0	
Wireline Communication DS1 from Data  Loading (see Common Equipment in Section 5.6)  Loading (see Common Equipment in Section 5.6)  Loading (see Common Equipment in Section 5.6)  A.8 8.4 Current Price Structure  Current Price Structure  Current Price Structure	(ә	Maintenance for Software Systems @		2	10			Estimate		2	
Current Price Structure  Courant Price Structure  (Operation 6.6)  (A.8 8.4 Current Price Structure  (A.8 8.	out	Wireline Communication DS1 from Da									
				8.8	8.4			Current Price S	tructure	4.8	
iedO)											
O)	)beı										
	<b>o</b> )										

### ISP Probe Information Collection (ISP8)

ce Quantity	Steady State *											Steady State *							_
Unit Price	Stead				250							Steac	12.5						
Retail Price *				well	ง Similar	rojects	ology	ology	ology										
Comparative Technology				Per Loral, Rockwell	Experience in Similar	Integration Projects	Existing Technology	Existing Technology	Existing Technology				Estimate						
Quantity (High)	te *											<b>*</b>							
Quantity (Low)	Introductory State *											Introductory State *							
Unit Price (High)	troduct				200							troduci	25						
Unit Price (Low)	u				250							2	12.5						
Years to Replacement (Life Cycle)					20														
Equipment Description					Jpgrade Software process probe data into link data	(includes some product development)				Note: Software is off-the-shelf technology and unit price does	not reflect product development, unless noted otherwise.		Maintenance for Software Systems @ 5% of Capital Cost						
		(Jue	etmo		uj ji	stic	leე Jou		tini					ıeuə		ာ ဗင်	era	dO)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.8-8 ISP PROBE INFORMATION COLLECTION, (ISP8)

### **4.6.9.** Personal Information Access Subsystem (PIAS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Personal Basic Information Reception	(PIA1)
Personal Interactive Information Reception	(PIA2)
Personal Mayday I/F	(PIA3)
Personal Route Guidance	(PIA4)

Each Equipment Package is described below.

### 4.6.9.1 Personal Basic Information Reception, (PIA1)

This Equipment Package provides the capability for travelers to interface with the ISP Subsystem Basic Information Broadcast Equipment Package and receive formatted traffic advisories including accurate traveling information concerning available travel options and their availability, and congestion information from their Personal Information Access Subsystem to include their homes, place of work, major trip generation sites, personal portable devices, and over multiple types of electronic media such as facsimile machines, portable AM/FM radios, and a pager processor.

This Equipment Package provides the processing of requested routing information by access to portions of TMC (or service provider), and of periodic requested location input from the traveler. This processor configures traveler routing as necessary. This type of mobile computer is currently called a "Personal Data Assistant" or PDA. Due to its small size the PDA may be further classified as a "subnotebook" or "palmtop" computer. The wireless communications capability may be built into the PDA, or may be incorporated in a separate module installed through a physical connector interface. The communication module may have attached to it the a separate antenna for wireless RF communications or may have the antenna built into the communications module or build into the PDA. The air interface for the communications module is the wireless RF WAN communications mode specified in this architecture. For purposes of the cost analysis this air interface is CDPD (Cellular Digital Packet Data.) Although other one way modes of communication may be free, this assumption was made in lieu of a service charge.

Similarly the location module can be built into the unit or also attached as a separate module using the same or similar interface standard. The location module indicates to the processor the location of the PDA/traveler. The technology used to implement this is design dependent, but for the purpose of cost analysis could use the GPS (Global Positioning System) satellite signals, possibly augmented with differential correction data received over the wireless data communications channel.

The remote system acts as the access point for external agents to the ITS system. This system ensures a common external interface (human and/or machine) while implementing

appropriate access security measures. Each Equipment Package accommodates request processing, external interfacing and internal interfacing. It is through a communication network that this system communicates with other subsystems in the ITS architecture. It is assumed that other external access systems to ITS architecture such as home PC's and work PC's already exist as part of the no ITS baseline. Only the remote access systems (PDA's) are used for this cost analysis. It is assumed that the other ITS architecture subsystems are inplace, and supporting facilities are operating. For example, the physical building that houses the operations for the remote access are included in the expenses for other subsystems and are not attributable to this system. The human interface operator is also assumed to be part of the other subsystems or terminators for the ITS architecture, specifically attributed to the staffing plans for the TMC and transit facilities. It is also assumed that maintenance personnel assigned to the TMC, and Roadside subsystems facilitate maintenance for the kiosk locations, in terms of physical repair.

### **4.6.9.2** Personal Interactive Information Reception, (PIA2)

This Equipment Package provides the capability for travelers to interface with the ISP Subsystem Infrastructure Equipment Packages including the Interactive Information Equipment Package, the Infrastructure Provided Route Selection, Yellow Pages and Reservation, and Ridesharing Equipment Packages. These capabilities are provided using the Personal Information Access Subsystem equipment such as cellular telephone, interactive TV, Personal Computer, and pager with alpha display using communication medium and equipment such as two-way radio, CATV, and wireless data transceivers.

PIA4 is a prerequisite package for PIA2. The equipment for PIA2 differs from PIA1 in that it is a separate equipment list allowing two way information exchange, and has higher processing level. Reflectively, PIA2 is subject to higher unit prices. This equipment is independent of PIA1 equipment.

### 4.6.9.3 Personal Mayday I/F, (PIA3)

This Equipment Package provides the capability to initiate a distress signal and cancel a prior issued manual request for help using the Personal Information Access Subsystem. This capability is provided using equipment such as a processor to automatically dial the Emergency Management Subsystem and provide location.

Specified equipment is similar in complexity to the equipment in PIA1. This technology is already installed in current model automobiles. It is assumed that this technology can be adapted to the PDA devices, or something similar.

### 4.6.9.4 Personal Route Guidance, (PIA4)

This Equipment Package provides the capability for route guidance. Thus, this Equipment Package provides the capability to receive travel information from the infrastructure, and perform the route planning process by itself. These capabilities are provided using equipment

such as a processor with GIS software and GUI using communication medium and equipment such as dialup lines, mobile satellite telephone, wireline modem, and wireline telephone.

This equipment differs from PIA1 in that it is a separate equipment list which is more sophisticated and reflectively, subject to higher unit prices. This equipment is independent of PIA1 equipment.

### Personal Basic Information Reception (PIA1)

Quantity	State *										State *								
Unit Price	Steady State *	0.25		0.1	0.08		0.5				Steady State	0.18		0.01	0.03				
Retail Price *		logy			yology	Φ						ructure							
Comparative Technology		Existing Technology	Price Structure	PCMCIA Prices	Existing Technology	Price Structure	Current Prices	(GPS World)			-	Current Price Structure	from GTE						
Quantity (High)	te *										te *								
Quantity (Low)	Introductory State *										Introductory State								
Unit Price (High)	troduc	0.4		0.15	0.1		0.8				troduc	0.2		0.01	0.04				
Unit Price (Low)	ㅁ	0.25		0.1	0.08		0.5				드	0.18		0.01	0.03				
Years to Replacement (Life Cycle)		7		7	7		7				-								
Equipment Description		Personal Digital Assistant		Modem Interface	Separate Antenna for Wireless Capability		GPS/DGPS		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Wireless Communication - Low Usage	(See Common Equipment in Section 5.6)	PDA Maintenance @ 2% of Capital Cost	GPS/DGPS Maintena				
		<u> </u>	(Ju	əwis	al Ir	ag-nestige	O Isi	ijiul						ıəşu	Mai	us &	bet	0)	

\* All prices are in thousands of 1995 dollars.

## Personal Interactive Information Reception (PIA2)

Quantity	Steady State *								Steady State *									95 dollars.
Unit Price	Steady	0.1							Steady	90.0		,	0.01					sands of 19.
Retail Price *		logy																* All prices are in thousands of 1995 dollars.
Comparative Technology		Existing Technology	Price Structure															* All p
Quantity (High)	te *								te *									
Quantity (Low)	Introductory State *								Introductory State *									
Unit Price (High)	troduct	0.2							troduct	0.12			0.01					
Unit Price (Low)	<b>I</b> n	0.1							<b>l</b> l	90.0			0.01					
Years to Replacement (Life Cycle)		7																
Equipment Description		Personal Digital Assistant Software Add-on					Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Monthly Service fee to ISP (\$5-10/Month)			PDA Maintenance @ 2% of Capital Cost					
		<u></u>	(10	ring vest		lsitir				_	(əɔuɐ	tens			iter	ədo	<b>o</b> )	

FIGURE 4.6.9-2 PERSONAL INTERACTIVE INFORMATION RECEPTION, (PIA2)

### Personal Mayday I/F (PIA3)

	Quantity	state *										tate *								
	Unit Price	Steady State	0.25		0.1	0.08		0.5				Steady State *	0.12			0.01	0.03			1
	Retail Price *		logy			nology	ъ Ф													
Comparative	Technology		Existing Technology	Price Structure	PCMCIA Prices	Existing Technology	Price Structure	Current Prices	(GPS World)											
O	(High)	te *										*								
Ousportity	(Low)	Introductory State *										Introductory State *								
Unit	Price (High)	troduct	0.4		0.15	0.1		0.8				troduct	0.18			0.02	0.04			
	Price (Low)	ul	0.25		0.1	0.08		0.5				띡	0.12			0.01	0.03			
Years to	Replacement (Life Cycle)		7		7	7		7												
	Equipment Description		Limited Processing & Multilight Display	(hus	Modem Interface	Separate Antenna for Wireless Capability		GPS/DGPS		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Monthly Service fee to ISP (\$10-15/Month)	fooun		Maintenance for Processor, Modem, Antenna @ 2% capital cost	Maintenance for GPS, DGPS @ 5% capital cost			
				(ţue		currir Inve		noN sO Isi	ţiu	ı) 				guce)	uəţ	rring Main		bera	0)	

\* All prices are in thousands of 1995 dollars.

### Personal Route Guidance (PIA4)

Quantity	tate *												tate *											
Unit Price	Steady State	0.4		3	L.O	0.08		0.1	0.5				Steady State	0.12	0.18		0.01	0.03		0.01	0.01	0.01	0.01	
Retail Price *		ology			<b>6</b>	nology	œ.								tructure									
Comparative Technology		Existing Technology	Price Structure		PCINCIA Prices	Existing Technology	Price Structure		Current Prices	(GPS World)					Current Price Structure	from GTE								
Quantity (High)	* e												* •			-								
Quantity (Low)	Introductory State												Introductory State *											
Unit Price (High)	troduct	9.0			0.15	0.1		0.15	0.8				troduct	0.18	0.2		0.02	0.04		0.01	0.02	0.01	0.01	
Unii Prio	<b>I</b>	0.4			- O	0.08		0.1	0.5				u L	0.12	0.18		000	0.03		0.01	0.01	0.01	0.01	
Years to Replacement (Life Cycle)		7		1		7		7	7															
Equipment Description		Personal Digital Assistant			Modem Interrace	Separate Antenna for Wireless Capability		Additional GIS / GUI Capability	GPS/DGPS		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Monthly Service fee to ISP (\$10-15/Month)	Wireless Communication - Low Usage	(See Common Equipment in Section 5.6)	PDA Maintenance @ 2% of Capital Cost		Maintenance of Hardware Components:	(Processor @ 2% of Capital Cost)	(GPS @ 5% of Capital Cost)	(GIS/GUI @ 5% of Capital Cost)	(Cell Based Radio @ 2% of Capital Cost)	
Ī			(jı	uəw		curr				init	)				(ə:	gue	uten B	rrin Mai		iter	ıəd	0)		

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.9-4 PERSONAL ROUTE GUIDANCE, (PIA4)

### **4.6.10. Parking Management Subsystem (PMS)**

This subsystem contains only one Equipment Package, Parking Management Subsystem (PMS1). This Equipment Package provides the capability to detect and classify properly equipped vehicles entering and exiting the parking facility, and to maintain database information with parking availability and pricing structure information. This capability is provided through the utilization of active/passive tag readers and database software containing parking pricing structure and current availability housed in a parking structure. Communications interface, to the ISP subsystem for information access, with wireline modem using wireline telephone is also supported.

The Parking Management Subsystem manages parking lots, provides parking status information to travelers, processes parking reservation requests, and communicates with the TMC, TRMS and ISP for information processing, and electronic payment services. The parking lot locations are assumed to be part of the No ITS Baseline. Also included in the existing system are the miscellaneous ramp meters, and signals identifying parking lot availability. Parking attendants, barriers and gates are also assumed to be present with or without the implementation of ITS. Video camera surveillance for security, variable message signs, and card readers are assumed to exist in the parking lot systems with or without the implementation of ITS functions.

Communication lines for each parking system are assumed to already exist in the form of both "twisted pair" telephone lines, and other levels of wireline capacity in close proximity to the sites. Only the connection links from the processor locations to adjacent communication lines are required. Additional equipment for data communication and added capacity for wire communications are included in the expense tabulation for each system.

Operations and maintenance for the system is assumed to be affected through an annual service contract to an Information Service Provider to perform hardware maintenance. This expense is estimated to be a lump sum annual service contract for each service subscriber. This subsystem processes information within the parking lot system and coordinates through the TMC communication system requests received from outside the system or sent to the system. Physical components required for the service (some of which already exist in the No ITS Baseline described above) include software and processor, communication links, video cameras, variable message signs, miscellaneous signal display, card readers, and meters. The processing system is an on-line system which processes all parking reservations and payments for parking lots and parking structures. The system also processes transactions which are paid by credit cards or debit cards. The module is connected to various types of electronic payment user interfaces (fixed or mobile, via beacon or cellular) and to the parking lot administration system. The module requires a separate software, processor, and workstation per parking lot location.

### Parking Management (PMS1)

Transmit   Factor   Existing Technology   2   5   5   5   5   5   5   5   5   5		Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity C (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
Futrance / Exit Ramp Meters   Futr				Intr	oducto	ry State	*			Steady State	tate *
Tag Readers		Entrance / Exit Ramp Meters	10	2	2			Existing Techno	ology	7	
Database and Software for Billing & Pricing   Database and Software for Billing & Pricing   Database and Software is off-the-shelf technology and unit price does   Database of Software is off-the-shelf technology and unit price does   Database of Software is off-the-shelf technology and unit price does   Database of Software is off-the-shelf technology   Database of Database of Software is off-the-shelf technology   Database of Database Database of Database of Database of Database of Database Database of Database of Database of Database Database of Database Database Database Database D	(;	•	10	7	2			Toll Road Tags	2-5	2	
Note: Software is off-the-shelf technology and unit price does   Note: Software is off-the-shelf technology and unit price does	μuə		10	10	15					10	
Cardinatication & Printer		Note: Software is off-the-shelf technology and unit									
CPU - 486 Workstation & Printer   CPU											
Communication Lines DS0 for Operator to PMS   Communication Lines DS0 for Operator to PMS   Communication Lines DS0 for Operator to PMS   Communication Lines DS0 for Oberator to PMS   Common Equipment in Section 5.6)   Communication DS1 from Data Loading   Common Equipment in Section 5.6)   Co		CPU	2	2	2					2	
DS0 to DMV & Enforcement & Financial Institution   20   0.5   1   Existing Technology   Existing Technology   Existing Technology   Existing Technology   Existing Technology   DS1 to ISP   Existing Technology   DS1 to TRMS   DS1 to TRMS   DS1 to TRMS   DS2 to TRMS   DS3 to TRMS   DS4 to TRMS   DS5 to TRMS   DS4 to TRMS		_	20	0.5	-			Existing Tech	nology	0.5	
DS1 to ISP		DS0 to DMV & Enforcement & Financi	20	0.5	-			Existing Techno	logy	0.5	
DS1 to Parking Service Provider			20	0.5	_			Existing Techno	logy	0.5	
DS3 to TRMS	ļiu		20	0.5	_			Existing Techno	logy	0.5	
Tag Readers Maintenance Contract @ 10% of Capital Cost   D.2   0.5   Existing Technology	I)		20	0.5	-			Existing Tech	nology	0.5	
Trag Readers Maintenance Contract @ 10% of Capital Cost   0.2 0.5     Entrance / Exit Ramp Meters @ 10% of Capital Cost   0.2 0.5     Entrance / Exit Ramp Meters @ 10% of Capital Cost   0.2 0.5     Entrance / Exit Ramp Meters @ 10% of Capital Cost   0.2 0.5     Database for Billing & Pricing @ 10% of Capital Cost   1 2     Current Price Strucure   1 2		DS3 to TMS	20	က	2			Existing Tech	nology	က	
Tag Readers Maintenance Contract @ 10% of Capital Cost   0.2 0.5     Entrance / Exit Ramp Meters @ 10% of Capital Cost   0.2 0.5     Entrance / Exit Ramp Meters @ 10% of Capital Cost   1 2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2   2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2   2   2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2   2   2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2   2   2   2     Database for Billing & Pricing @ 10% of Capital Cost   1 2   2   2   2   2   2   2     Database for Billing & Pricing Communication DS3 from Data Loading   2 4   72   2   2   2   2   2   2   2   2											
Tag Readers Maintenance Contract @ 10% of Capital Cost         0.2         0.5         0.5           Entrance / Exit Ramp Meters @ 10% of Capital Cost         0.2         0.5         0.5           Database for Billing & Pricing @ 10% of Capital Cost         1         2         Current Price Strucure           PMS Wireline Communication DS0 from Data Loading         0.6         1.2         Current Price Strucure           Rec Common Equipment in Section 5.6)         0.6         1.2         Iron GTE           DMV Wireline Communication DS0 from Data Loading         4.8         8.4         Current Price Strucure           Rec Common Equipment in Section 5.6)         4.8         8.4         Current Price Strucure           ISP Wireline Communication DS1 from Data Loading         4.8         8.4         Current Price Strucure           Country Section 5.6)         4.8         8.4         Current Price Strucure           TMS Wireline Communication DS3 from Data Loading         4.8         8.4         Current Price Strucure           Country Section 5.6)         4.8         8.4         Current Price Strucure           Country Section 5.6)         4.8         8.4         Current Price Strucure           Country Section 5.6)         4.8         8.4         Current Price Strucure           Country Structure Communication D				Intr	oducto	ry State	*			Steady State	tate *
Entrance / Exit Ramp Meters @ 10% of Capital Cost Database for Billing & Pricing @ 10% of Capital Cost Database for Billing & Pricing @ 10% of Capital Cost Database for Billing & Pricing @ 10% of Capital Cost PMS Wireline Communication DS0 from Data Loading See Common Equipment in Section 5.6) DMV Wireline Communication DS1 from Data Loading See Common Equipment in Section 5.6) TRMS Wireline Communication DS1 from Data Loading See Common Equipment in Section 5.6) TRMS Wireline Communication DS3 from Data Loading See Common Equipment in Section 5.6) TMS Wireline Communication DS3 from Data Loading See Common Equipment in Section 5.6) TMS Wireline Communication DS3 from Data Loading See Common Equipment in Section 5.6) TMS Wireline Communication DS3 from Data Loading See Common Equipment in Section 5.6)		Tag Readers Maintenance Contract @ 10% of Capital Cost		0.2	0.5					0.2	
Database for Billing & Pricing @ 10% of Capital Cost and Data Loading	ξĐ			0.2	0.5					0.2	
PMS Wireline Communication DS0 from Data Loading   0.6   1.2   Current Price Strucure   Irom GTE   Irom GTE	วนเ			-	7					_	
See Common Equipment in Section 5.6)from GTEMay Wireline Communication DS0 from Data Loading0.61.21 See Common Equipment in Section 5.6)4.88.41 See Common Equipment in Section 5.6)4.88.42 TRMS Wireline Communication DS1 from Data Loading4.88.42 See Common Equipment in Section 5.6)4.88.43 See Common Equipment in Section 5.6)4.88.44 See Common Equipment in Section 5.6)4.88.4	:uə			9.0	1.2			Current Price S	trucure	9.0	
DMV Wireline Communication DS0 from Data Loading   0.6   1.2     1.2								from GTE			
See Common Equipment in Section 5.6)4.88.4ISP Wireline Communication DS1 from Data Loading4.88.4Csee Common Equipment in Section 5.6)4.88.4TMS Wireline Communication DS3 from Data Loading2472TMS Wireline Communication DS3 from Data Loading2472(see Common Equipment in Section 5.6)2472				9.0	1.2			_		9.0	
ISP Wireline Communication DS1 from Data Loading       4.8       8.4         Rese Common Equipment in Section 5.6)       4.8       8.4         TRMS Wireline Communication DS3 from Data Loading       4.8       8.4         TMS Wireline Communication DS3 from Data Loading       24       72         (see Common Equipment in Section 5.6)       24       72											
(see Common Equipment in Section 5.6)4.88.4TRMS Wireline Communication DS1 from Data Loading4.88.4(see Common Equipment in Section 5.6)2472(see Common Equipment in Section 5.6)2472		ISP Wireline Communication DS1 from Data Loadi		4.8	8.4					4.8	
TRMS Wireline Communication DS1 from Data Loading (see Common Equipment in Section 5.6)  TMS Wireline Communication DS3 from Data Loading (see Common Equipment in Section 5.6)	it6.										
(see Common Equipment in Section 5.6)  TMS Wireline Communication DS3 from Data Loading 24 72	iəd	•		4.8	8.4					4.8	
Data Loading 24 72	O)										
(see Common Equipment in Section 5.6)		TMS Wireline Communication DS3 from Data Loading		24	72			<b>—</b>		24	
		(see Common Equipment in Section 5.6)						<b>&gt;</b>			

\* All prices are in thousands of 1995 dollars.

### 4.6.11. Planning Subsystem (PS)

This subsystem contains only one Equipment Package, Data Collection and ITS Planning (PS1). This service collects data from all center functions in support of ITS planning activities. Staff requirements are only those dedicated to ITS activities. This staff may consist of MPO employees, or other regional planners.

### Data Collection and ITS Planning (PS1)

Quantity	tate *							tate *								
Unit Price	Steady State *	15	20					Steady State *	270	180						
Retail Price *		logy	logy													
Comparative Technology		Existing Technology	Existing Technology													
Quantity (High)	te *							te *								
Quantity (Low)	Introductory State *							Introductory State *								
Unit Price (High)	ıtroduc	30	40					itroduc	330	220						
Unit Price (Low)	ı	15	20					ı	270	180						
Years to Replacement (Life Cycle)		10	10													
Equipment Description		Workstations (3)	Software and Processing						2 Full Time - Mid Level Planners @ 150k each	1 Half Time Senior Level Planner @ 200k each	Note: Salary Costs are Fully Loaded Prices (Base Salary, Overhead,	Overtime, Benefits, etc.)				
		^			9A-n Bita	nitial	I)		(7)	(93	eugu		Rec	ber	0)	

\* All prices are in thousands of 1995 dollars.

### 4.6.12. Roadway Subsystem (RS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Automated Road Signing	(RS1)
Roadside Signal Priority	(RS2)
Roadway Freeway Control	(RS3)
Roadway Signal Controls	(RS4)
Roadway Basic Surveillance	(RS5)
Roadway HOV Usage	(RS6)
Roadway In-Vehicle Signing	(RS7)
Roadway Incident Detection	(RS8)
Roadway Intersection Collision System	(RS9)
Roadway Pollution and Environmental Hazards Indicators	(RS10)
Roadway Probe Beacons	(RS11)
Roadway Reversible Lanes	(RS12)
Roadway Systems for AHS	(RS13)
Roadway Traffic Information Dissemination	(RS14)

For the cost analysis, the roadway network is assumed to be partially outfitted with roadway sensors. As part of the No ITS Baseline it is assumed that the Central Business District (CBD) is already subject to a signal control system. This system requires software upgrades to meet the specifications of the ITS system, and requires hardware replacement as components reach the end of their useful life. However, these system components are inplace, and would be an expense with or without the implementation of ITS. The additional expense for signal control stems from the use of enhanced technology in area wide signal controls. These costs are incurred when existing systems reach the end of their useful life. The evaluatory design parameters for the signal system emulate a staggered deployment time frame in order to match typical technology replacements.

Traffic control and monitoring for incident detection is performed via roadway loop detectors, camera surveillance and radar units, also assumed to be part of the existing infrastructure, although in limited use. Likewise variable message signs, and video cameras are assumed to be in limited use. These components are also expected to exist and maintain their existence in the future regardless of ITS implementation. The additional expense for these roadside physical elements stems from the increased coverage of traffic control and monitoring.

Roadside communication systems are assumed to be in-place along the entire roadway network. Telephone lines, cable lines and power lines are all assumed to be readily available for supporting the ITS architecture. The expense associated with utilizing these power and communication lines is included in the architecture as an annual operation expense, and the expenses for connections are included in the unit prices for individual devices.

The roadside maintenance staff and equipment departments are assumed to be in existence and operating. The maintenance department for non-ITS roadside components is assumed to also be responsible for the ITS roadside components. Specific component maintenance expenses related to ITS implementation are detailed in the following worksheets. These maintenance expenses are counted as recurring expenditures. No expenditure for training maintenance staff is included in the recurring expenditure. It is assumed that as the system management strategies for these devices become increasingly complex, this complexity is offset by the increased user interfaces which becomes easier to use and require less initial training. Many of the roadside maintenance departments throughout the US are currently staffed with trained electricians, electrical engineers, supervisors and other technically trained maintenance personnel. Training expenses for these staff members are assumed to be minimal, and part of the normal maintenance operation expenses of maintaining roadside equipment.

The Non-recurring expenses associated with connecting specific devices to these existing systems have been included in the unit prices for the particular devices. The basis for this cost analysis assumes that connections from additional loop detectors, cameras, radar units, and variable message signs average approximately 300 feet in length. The effective life cycle of these communications connections are assumed to be the same as the devices they serve. The maintenance cost of the communications links is imbedded in the line lease costs and are, therefore, not specifically identified in the cost analysis. The basis for the lease cost stems from the previously discussed wireline communications common equipment in section 4.6, above. The number and type of leased lines and their unit costs are included in the Equipment Package worksheets.

Each Equipment Package is described below.

### 4.6.12.1 Automated Road Signing, (RS1)

Roadside beacons which may be locally and autonomously controlled from probe transmissions or centrally controlled from the virtual TMC.

### 4.6.12.2 Roadside Signal Priority, (RS2)

This Equipment Package provides the capability to receive vehicle signal priority requests and control roadside signals accordingly. This package is dependent on the existence of RS4, Signal Controls. The add-on unit prices are for software and processor upgrades to the existing signal control system. The wireline communication line expenditures are taken into account in the TMS subsystem.

### 4.6.12.3 Roadway Freeway Control, (RS3)

This Equipment Package provides the functionality to control freeway traffic. Thus, a prerequisite Equipment Package for this package is RS5, Basic Surveillance, and RS14

Roadway Traffic Information Dissemination. This package utilizes the information from these prerequisite packages in combination with new equipment to provide freeway traffic management. New equipment includes ramp meters, their controllers, power supplies, etc. The CMS and other freeway control effectors which control traffic on freeways are in RS14.

### 4.6.12.4 Roadway Signal Controls, (RS4)

This Equipment Package provides the capabilities to control traffic signals at major intersections and on arterials roadways for urban areas. This Equipment Package is generally constrained to a single jurisdiction. Multijurisdictional coordination is accomplished through the TMS subsystem. The equipment in this package includes local controller upgrades and connections to the linked signal system.

### 4.6.12.5 Roadway Basic Surveillance, (RS5)

This Equipment Package provides the capabilities to monitor traffic flow through major intersections and on major arterials and highways for urban areas and to monitor road conditions using fixed equipment such as loop detectors and wireline communications. Standard color video cameras are used for image surveillance in conjunction with loop detection systems. Other devices may be available in the current state-of-the-practice roadway surveillance projects throughout the US. There are numerous technical and financial tradeoffs for any of the systems. This analysis is best performed on a site specific local deployment platform. The leased line wireline communication costs are delineated in the TMS subsystem.

### 4.6.12.6 Roadway HOV Usage, (RS6)

This Equipment Package provides the capability to detect the HOV lane usage using sensor equipment. For lanes that become HOV or High Occupancy Toll (HOT) lanes during certain time of the day, it provides display equipment to notify users of their status. The leased line wireline communication costs are delineated in the TMS subsystem.

### 4.6.12.7 Roadway In-Vehicle Signing, (RS7)

This Equipment Package provides the capability to detect local traffic flow conditions, corroborate them with a traffic management subsystem, and distribute them to the user over a short-range interface such as a radio beacon. These beacons are one way communication devices.

### 4.6.12.8 Roadway Incident Detection, (RS8)

This Equipment Package provides incident detection capability to reside at the roadside. For example, advanced CCTV's with built-in incident detection algorithms would allow the actual detection function to be roadside rather than transmitting images to a center for visual or automated detection.

### 4.6.12.9 Roadway Intersection Collision System, (RS9)

This Equipment Package provides the capability to determine the probability of a collision in the intersection and send appropriate warnings and/or control actions to the approaching vehicles using a short-range interface. This Equipment Package also provides the capability that the traffic control signals provide signal indication information to the vehicles using a short-range interface and the vehicle performs the determination of the probability of collision in the intersection. This package covers intersections between vehicles and railroad at grade crossings. The prerequisite Equipment Package for this package are RS4 and RS2.

### 4.6.12.10 Roadway Pollution and Environmental Hazards Indicators, (RS10)

This Equipment Package provides the capability for remote communications for collecting and transmitting air pollution due to vehicle emission data and environmental hazards such as icy road conditions and fog. Roadside devices for collecting environmental conditions and emissions monitoring are included in this roadside Equipment Package. Other expenditures for Emissions and Environmental Data Management are identified in the EMMS subsystem.

### 4.6.12.11 Roadway Probe Beacons, (RS11)

This Equipment Package provides the capabilities to monitor traffic flow in major intersections and on main highways for urban areas and to monitor road conditions using mobile equipment and wireless communication. For example, vehicle probe data or aerial surveillance data. These beacons are two way communication devices.

### 4.6.12.12 Roadway Reversible Lanes, (RS12)

This Equipment Package provides the capability for control of reversible lanes using sensor and actuator type equipment. This Equipment Package also provides the capability to notify users the direction of the reversible lanes using electronic lane signs.

### 4.6.12.13 Roadway Systems for AHS, (RS13)

This Equipment Package provides the capability of safely controlling access to and egress from an Automated Highway System. This Equipment Package also provides the capability for roadside to vehicle communication. These capabilities are provided using equipment such as a lane check-in or check-out beacon and special purpose vehicle signing beacons. Access control devices may use RS12 equipment.

### 4.6.12.14 Roadway Traffic Information Dissemination, (RS14)

This Equipment Package provides the roadside elements of traffic information dissemination including CMS and HAR. Also included are the fixed message signs which are fiber optic advanced warning signs. Some of these fiber optic advanced warning signs are connected to

remote roadside locations which are specifically targeted as either environmental hazards or main decision points for alternate traffic routing. The wireline communications to these devices are depicted in the TMS subsystem.

### Automated road signing (RS1)

Quantity	Steady State *									Steady State *								
Unit Price	Steady	2								Steady	0.5							
Retail Price *		:xist.	ses															
Comparative Technology		Ref. Seimens Exist.	Technology Prices															
Quantity (High)	te *									* *								
Quantity (Low)	Introductory State *									Introductory State *								
Unit Price (High)	troduct	8								troduct	0.8							
Unit Price (Low)	In	2								Ī	9.0							
Years to Replacement (Life Cycle)		2																
Equipment Description		Radio Beacons (per location)									Beacon Maintenance (10% of Capital Cost)	Leased Line Costs borne by TMC						
			(1	uə		al lr		sitin	II)			(əɔu	ะนอ		s su	ber	O)	

\* All prices are in thousands of 1995 dollars.

### Roadside Signal Priority (RS2)

Quantity	state *								State *								
Unit Price	Steady State *	4	2						Steady State *	0.05							
Retail Price *		ology ref.	Highway	LBA projects						0.1							
Comparative Technology		Existing Technology ref.	Massachusetts Highway	Department per LBA projects						Exist. Tech.							
Quantity (High)	te *								*								
Quantity (Low)	Introductory State *								Introductory State *	<b>S</b>							
Unit Price (High)	troduct	8	2						troduct	0.2							
Unit Price (Low)	п	4	2						드	0.05							
Years to Replacement (Life Cycle)		2	10														
Equipment Description		Receiver (per intersection - 2 total)	Signal Controller - Add-on to base capability (per intersection)							Testing & Calibration Annual Contract (\$50 per intersection)	Leased Line Costs borne by TMC						
						PFe Pita	sitini	)		'	(əɔuɐ		Recr	atic	ədC	)	

FIGURE 4.6.12-2 ROADSIDE SIGNAL PRIORITY, (RS2)

\* All prices are in thousands of 1995 dollars.

### Roadway Freeway Control (RS3)

Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
		Int	roduct	Introductory State *	*			Steady State	State *
Ramp Meters (per location)						Existing Site			
Controller, Power etc. included	5	30	20			Installations		30	
.uəi						Prices from			
						New England			
						and Virginia			
						Projects per			
						LBA			
Car									
iul.									
		Int	roduct	Introductory State *	*			Steady State	State *
Leased Line Costs borne by TMCS							0.1		
			L						
invaintenance for Kamp Meters @ 5% of Capital Cost		<u>.</u>	7.5					ა.	
% security									
)era									
10)									

### Roadway Signal Controls (RS4)

Quantity	state *									State *								
Unit Price	Steady State *	40	2							Steady State *		0.8						
Retail Price *		ology ref.	Highway	LBA projects														
Comparative		Existing Technology ref.	Massachusetts Highway	Department per LBA projects														
Quantity (High)	te *									te *								
Quantity (Low)	Introductory State *									Introductory State *								
Unit Price (High)	troduct	20	10							troduct		4.1						
Unit Price (Low)	ını	40	2							ln		0.8						
Years to Replacement (Life Cycle)		20	20															
Equipment Description		Linked Signal System LAN	Local Controller Upgrades (per intersection)								Leased Line Costs borne by TMC	Maintenance for LAN @ 2% of Capital Cost						
			()	uəı		-Rec oital	1 Isitir	II)	,		(	əsur	utens B	y sı y sı	)DGL	<b>)</b>	'	

FIGURE 4.6.12-4 ROADWAY SIGNAL CONTROLS, (RS4)

\* All prices are in thousands of 1995 dollars.

### Roadway Basic Surveillance (RS5)

Equipment Description   Name of the control of th	Paragraph   Para							•				
Cops - 1 Double Set w/ Controller, Power, etc. (per location)	Introductory State		Equipment Description	Years to Replacement (Life Cycle)			Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
Coop	Coops - 1 Double Set w/ Controller, Power, etc. (per location)				Int	roducto	ry State	*			Steady	State *
Video Cameras (color)	Video Cameras (color)		- 1 Double Set w/ Controller, Power, etc. (per	2	2	8			Existing Site	9	2	
Video Camera location   10 30 50   Prices from 40     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50   New England 30     Towers (per camera location   10 30 50 50   New England 30 50 50     Towers (per camera location   10 50 50 50 50 50 50 50 50 50 50 50 50 50	Video Cameras (color)	(1							nstallations			
Towers (per camera location)	Copy Replacement Maintenance (10% of capital)	uə	Video Cameras (color)	10	30	20			Prices from	40	30	
Capital Internations	Cop Replacement Maintenance (10% of capital)		Towers (per camera location)	20	30	20			New England	30	30	
Cope Replacement Maintenance (10% of capital)	Cop Replacement Maintenance (10% of capital)								and Virginia			
Cop Replacement Maintenance (10% of capital)	(Initial Capital Capital Capital)  Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Nideo Cameras (2% of capital)  Leased Line Costs borne by TMC  (Operations & Maintenance (10% of capital)  Ocidate								Projects per			
Coop Replacement Maintenance (10% of capital)   Loop Replacement Maintenance	(Initial Cap  Loop Replacement Maintenance (10% of capital)  Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Operations & Maintenance (10% of capital)  October 15 2.5  October 25 0.8  October 35								-BA			
Loop Replacement Maintenance (10% of capital)  Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Ramp Meters (5% of capital)  Leased Line Costs borne by TMC  Operation	Loop Replacement Maintenance (10% of capital)  Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Operations & Maintenance (10% of capital)											
Loop Replacement Maintenance (10% of capital)  Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Operations	Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Operations  Operations											
Coop Replacement Maintenance (10% of capital)	Leased Line Costs borne by TMC  Maritenance (10% of capital)  Ramp Meters (5% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Operations  Operatio	ļiuļ										
Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital) Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Operations	Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Operations	)										
Loop Replacement Maintenance (10% of capital)  Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC   Maintenance (10% of capital)  O.5 0.8  1.5 2.5  O.6 1  Operation	Leased Line Costs borne by TMC  Operations  Operations											
Loop Replacement Maintenance (10% of capital)  Ramp Meters (5% of capital)  Ramp Meters (2% of capital)  Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Coperation  Operation  Operation	Loop Replacement Maintenance (10% of capital)   0.5   0.8				Int	roducto	ry State	*			Steady	State *
Ramp Meters (5% of capital) Video Cameras (2% of capital) Leased Line Costs borne by TMC	Ramp Meters (5% of capital)   1.5 2.5     Video Cameras (2% of capital)   0.6 1     Leased Line Costs borne by TMC		Loop Replacement Maintenance (10% of capital)	-	0.5	8.0					0.5	
Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Leased Line Costs borne by TMC  Operations  Oherst in the costs borne by TMC  Operations  Operation	Video Cameras (2% of capital)  Leased Line Costs borne by TMC  Coperations & Maintenance   0.6 1   1   1   1   1   1   1   1   1   1	(ə	Ramp Meters (5% of capital)		1.5	2.5					1.5	
Operations & Maintens	Coperations & Maintens (Operations	วนเ	Video Cameras (2% of capital)		9.0	-					9.0	
	(Operations & Ma		Leased Line Costs borne by TMC									
	& snoitsneqO)											
	(Operation											
TeqO)												
0)		beı										
	* All prices are in the	0)										
	* All prices are in th											

FIGURE 4.6.12-5 ROADWAY BASIC SURVEILLANCE, (RS5)

### Roadway HOV Usage (RS6)

Quantity	state *												state *											
Unit Price	Steady State	2	9	20	30	30							Steady State *	0.5	9.0	2.5	9.0	က						
Retail Price *		9	9	50	40	40																		
Comparative Technology		Existing Site	Installations	Prices from	New England	and Virginia	Projects per	LBA						Estimate	Estimate	Estimate	Estimate	Estimate						
Quantity (High)	te *												*											
Quantity (Low)	Introductory State *												Introductory State *											
Unit Price (High)	troduct	8	8	75	20	20							troduct	8.0	0.8	4	-	2						
Unit Price (Low)	<b>I</b>	2	9	20	30	30							드	9.0	9.0	2.5	9.0	က						
Years to Replacement (Life Cycle)		2	20	20	20	20																		
Equipment Description		Loop Detectors (1 double set)	Fixed Lane Signals (each)	Fixed Message Boards (each)	Video Monitoring / Enforcement (each)	Software / Billing Enforcement		Paric		ופו				Loop Detectors (10% of capital)	Fixed Lane Signals (10% of capital)	Fixed Message Boards (5% of capital)	Video Cameras (2% of capital)	Enforcement Maintenance (10% of capital)	Leased Line Costs borne by TMC	Suc	nipe	ıad	0)	
			(1	uə					lon Ca	/ lsii	iul	)			(ә	วนเ	euə		currir & Ma		oits:	ıəd	o)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.12-6 ROADWAY HOV USAGE, (RS6)

### Roadway In-Vehicle Signing (RS7)

ice Quantity	Steady State *					Steady State *								
Unit Price	Stea	2	က			Stea	0.5							
Retail Price *		Exist.	seo											
Comparative Technology		Ref. Seimens Exist.	Technology Prices				Exist. Tech.							
Quantity (High)	te *					te *								
Quantity (Low)	Introductory State *					Introductory State *								
Unit Price (High)	ıtroducı	8	∞			itroduci	0.8							
Unit Price (Low)	-L	2	ო			7	0.5							
Years to Replacement (Life Cycle)		2	10											
Equipment Description		Signal Transmitter (4 Beacons per intersection)	Localized Controller				Beacon Maintenance (10% of Capital Cost)	Communication from TMC to Beacons is included in TMC Costs						
				nceSin In	sitinl)				urrin k Mai	Reci	ije	ədç	o)	

\* All prices are in thousands of 1995 dollars.

### Roadway Incident Detection (RS8)

Quantity	tate *										tate *										
Unit Price	Steady State *	30	30								Steady State	3									
Retail Price *		30	30																		
Comparative Technology		Exist. Tech.	Exist. Tech.																		
Quantity (High)	е *										e *										
Quantity (Low)	Introductory State *										Introductory State										
Unit Price (High)	roducte	20	20								roducte	2									
P. P. J	Int	30	30								Int	3									
Years to Replacement (Life Cycle)		10	20																		
Equipment Description		Advanced CCTV w/detection algorithm (per location)	Towers for Mounting (per location)									CCTV (10% of capital)	Leased Line Costs borne by TMC								
-		٩		uəı			lon-	tini	)			U		gue	uə		გ s იემ	iter	əd	0)	

FIGURE 4.6.12-8 ROADWAY INCIDENT DETECTION, (RS8)

### Roadway Intersection Collision System (RS9)

Equipment Description	Replacement (Life Cycle)	P. ig	Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
		<u>=</u>	troduct	Introductory State *	*		=	Steady State	state *
Communication Lines (use existing)									
Communication to Local Signage (per site)	20	9	6			15k / mile	8	9	
Roadside Hardware, Software and sensors (per intersection)	10	100	200			Estimate		100	
						Per Loral, Rockwell exper. in	kwell exper. in		
						Similar Integration Projects	tion Projects		
		ıı	troduct	Introductory State	te *			Steady State	state *

FIGURE 4.6.12-9 ROADWAY INTERSECTION COLLISION SYSTEM, (RS9)

# Roadway Pollution and Environmental Hazards Indicators (RS10)

				_					
Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
		Int	Introductory State *	ry State	*			Steady State *	State *
Continuous Emissions Monitoring Stations Design	10	3	9			Ref. EPA 454-		3	
(per emissions design)						R-93-042			
Types - NO, NO2, NOx Analyzer	10	7	7					7	
Ozone Analyzer	10	9	80					9	
- SO2 Analyzer	10	7	7					7	
CO Analyzer	10	7	-					7	
Peripherals (per emissions type)	10	13	17					13	
Shelter, Site Preparation (per site)	20	16	20					16	
Environmental Site Installation	20	22	30					25	
Equipment (Humidity, Pressure, Temperature, Wind, Precip., etc)	10	20	25					20	
		Int	Introductory State	ry State	* 0			Steady State	State *
TMC Wireline Communication DS0 from Data Loading						Current Price Structure	tructure		
(see Common Equipment in Section 5.6)		9.0	1.2			from GTE		9.0	
	_		_	_					

FIGURE 4.6.12-10 ROADWAY POLLUTION AND ENVIRONMENTAL HAZARDS INDICATORS, (RS10)

### Roadway Probe Beacons (RS11)

Quantity	State *										State *												35 dollars.
Unit Price	Steady State *	2									Steady State *	0.5											sands of 199
Retail Price *		xist.	es																				* All prices are in thousands of 1995 dollars.
Comparative Technology		Ref. Seimens Exist.	TechnologyPrices									Exist. Tech.											* All p
Quantity (High)	te *										te *												
Quantity (Low)	Introductory State *										Introductory State *												
Unit Price (High)	troduci	8									troduct	0.8											
Unit Price (Low)	ul	9									띡	9.0											
Years to Replacement (Life Cycle)		2																					
Equipment Description		Radio Beacons (per location)										Beacon Maintenance (10% of Capital Cost)	Leased Line Costs borne by TMC										
		_	(:	uə	etm Stm		lon Cal	iul	)			1		guc	uə		က္ခ noe	No Suo	iżer	əd	0)		

FIGURE 4.6.12-11 ROADWAY PROBE BEACONS, (RS11)

### Roadway Reversible Lanes (RS12)

Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
		In	troduct	Introductory State	* •			Steady State	state *
Gates (per location)	20	100	150			Existing Site	100	100	
CMS (per location)	20	20	75			Installations	20	90	
Loop Detectors (double set, per location)	5	9	8			Prices from	9	2	
1.	20	9	6			New England	8	9	
	20	25	20			and Virginia	25	25	
						Projects per			
Note: Software is off-the-shelf technology and unit price does						LBA			
not reflect product development.									
21111									
1									
		ļuļ	troduct	Introductory State *	*			Steady State *	state *
Gates (2% of capital)		7	3			Estimate		7	
CMS (5% of capital)		2.5	4			Estimate		2.5	
Loops (10% of capital)		0.5	0.8			Estimate		0.5	
Leased Line Costs borne by TMC									

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.12-12 ROADWAY REVERSIBLE LANES, (RS12)

### Roadway Systems for AHS (RS13)

rice Quantity	Steady State *						Steady State *		10						
Unit Price	Ste	2	2				Ste		0.5	0.5					
Retail Price *															
Comparative Technology		Estimate	Estimate						Exist. Tech.	Exist. Tech.					
Quantity (High)	.е. *						* e								
Quantity (Low)	Introductory State *						Introductory State *								
Unit Price (High)	troducte	8	8				roduct		0.8	0.8					I
Unit Price (Low)	Int	2	2				lu(		0.5	0.5					
Years to Replacement (Life Cycle)		10	10												
Equipment Description		Check In / Check Out Beacons	Signing (beacons)	Access Control devices may utilize RS12 equipment				Leased Lines from TMC to beacons borne by TMCs	Beacon Maintenance (10% of Capital Cost)	Beacon Maintenance (10% of Capital Cost)					
		)		əmisəv	Recur oftal In	ijinl)				eusne	curri 8. M	iter	ədO	)	

FIGURE 4.6.12-13 ROADWAY SYSTEMS FOR AHS, (RS13)

\* All prices are in thousands of 1995 dollars.

# Roadway Traffic Information Dissemination (RS14)

	Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
		<u>lu</u>	Introductory State *	ry State	*			Steady State	tate *
	20	80	120			Existing	100	80	
	20	16	20			Existing	16	16	
Fixed Fiber Optic Advanced Warning Signs	10	10	15			Existing	12	10	
Fixed Fiber Optic Advanced Warning Signs at Remote EMS Loc.	10	18	22			Existing	20	18	
Tower Structures for CMS	20	100	150			Existing	100	100	
CMS (5% of capital) HAR (5% of capital) Fixed Fiber Optic Advanced Warning Signs (5% of capital) Fixed Fiber Optic Advanced Warning Signs at Remote EMS Loc. (10% of capital)		1.8 1.8	Introductory State *  6  8  1  0.8  2.2	ıry State		Estimate Estimate Estimate		Steady State  4  0.8  0.5  1.8	tate *
Leased Line Costs borne by TMCS									

\* All prices are in thousands of 1995 dollars.

### 4.6.13. Remote Traveler Support Subsystem (RTS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Remote Basic Information Reception	(RTS5)
Remote Interactive Information Reception	(RTS1)
Remote Mayday I/F	(RTS2)
Remote Transit Fare Management	(RTS3)
Remote Transit Security I/F	(RTS4)

Each Equipment Package is described below.

### 4.6.13.1 Remote Basic Information Reception, (RTS5)

This Equipment Package provides the capability for travelers to interface with the ISP Subsystem Basic Information Broadcast Equipment Package and receive formatted traffic advisories including accurate traveling information concerning available travel options and their availability, and congestion information at the Remote Traveler Subsystem. The interface used for this package is a kiosk. Wireline communications to the kiosks are included in a leased line unit price per kiosk, as described in section 4.6, above.

### **4.6.13.2** Remote Interactive Information Reception, (RTS1)

This Equipment Package provides the capability for travelers to interface with the ISP Subsystem Infrastructure Equipment Packages including the Interactive Interactive Information Equipment Package, the Infrastructure Provided Route Selection, Yellow Pages and Reservation, and Dynamic Ridesharing Equipment Packages. These capabilities are provided using the Remote Traveler Subsystem equipment such as interactive TV and kiosk using communication medium and equipment such as CATV and wireline and wireless data transceivers. (Wireless communication is possible but not priced in this analysis.) This Equipment Package has a prerequisite Equipment Package RTS5. Equipment for RTS1 include processor add-ons to the existing system in RTS5, as well as additional communication requirements, and an interactive information display.

### **4.6.13.3 Remote Mayday I/F, (RTS2)**

This Equipment Package provides the capability to initiate a distress signal and cancel a prior issued manual request for help using the Remote Traveler Subsystem. This capability is provided using equipment such as a processor to automatically dial the Emergency Management Subsystem and provide location. This equipment may be stand alone devices, similar to the emergency MAYDAY devices in the PIAS subsystem, or may be incorporated into the kiosk location in RTS5. The difference in this equipment from the equipment in the PIAS subsystem is the absence of the GPS/DGPS requirement as the Remote Mayday I/F is at a fixed location.

### 4.6.13.4 Remote Transit Fare Management, (RTS3)

This Equipment Package provides the capability for the traveler to use a fare medium for all applicable surface transportation services, to pay without stopping, have payment media automatically identified as void and/or invalid and eligibility verified, and allow for third party payment from a remote location, i.e., other than the transit vehicle. In addition, capability to provide expansion into other uses for payment medium such as retail and telephone and for off-line billing for fares paid by agencies is supported.

This Equipment Package is independent of the kiosk locations in terms of functionality. However, in practice these locations may be the most likely locals for remote ITS services. The equipment for this remote ticket vending include ticket vending machines, similar to the SMART CARD technology. Wireline communication to the electronic payment instrument and financial institutions is provided through existing lines. The lease line charge for these lines are as described in the common equipment section 4.6, above.

### 4.6.13.5 Remote Transit Security I/F, (RTS4)

This Equipment Package provides the capability to monitor the safety of transit users at Remote Traveler Subsystem locations with direct interface to the Transit Management Subsystem. The equipment for this package augments the MAYDAY I/F located at kiosks, as well as adding security to the transit customers along the transit routes. This equipment is independent of RS5.

### Remote Basic Information Reception (RTS5)

7   35   50   Ref George Mason   35     7   10   12   Pilot Test on   10     7   0.8   1   Portable Kiosks   0.8     7   0.1   0.2   Pilot Test on   0.1     7   0.1   0.2   Pilot Test on   0.1     8   1   Portable Kiosks   0.8     9   1   Portable Kiosks   0.8     1   1   1   1   1   1     1   1   1	Equipment Description
7 10 12 Pilot Test on Portable Kiosks 7 0.8 1 Portable Kiosks 7 0.1 0.2 Portable Kiosks  1	
7 0.8 1  7 0.1 0.2  Introductory State * Current Price Structure  4.8 8.4 from GTE from GTE	
7   0.1   0.2	
Introductory State *  4.8 8.4 Current Price Structure from GTE  3.5 5	
Introductory State *  4.8 8.4 Current Price Structure from GTE  3.5 5	
htroductory State *  8.4 Current Price Structure from GTE  5	price does
8.4 Current Price Structure from GTE	
8.4 Current Price Structure from GTE	
8.4 Current Price Structure from GTE	
from GTE	
ıo	

FIGURE 4.6.13-1 REMOTE BASIC INFORMATION RECEPTION, (RTS5)

# Remote Interactive Information Reception (RTS1)

\* All prices are in thousands of 1995 dollars.

### Remote Mayday I/F (RTS2)

e Quantity	Steady State *								Steady State *							
Unit Price	Stead	0.1							Stead	9.0		0.02				
Retail Price *		ology								tructure						
Comparative Technology		Existing Technology								Current Price Structure	from GTE					
Quantity (High)	te *								* *							
Quantity (Low)	Introductory State *								Introductory State *							
Unit Price (High)	troduct	0.15							troduct	1.2		0.03				
Unit Price (Low)	<b>I</b> I	0.1							٤	9.0		0.02				
Years to Replacement (Life Cycle)		2														
Equipment Description		Interface for Limited Processor					Note : Software is off-the-shelf technology and unit price does	not reflect product development.		Communication Line DS0 from Data Loading	(see Common Equipment in Section 5.6)	Maintenance on Interface @ 2% of Capital Cost				
			(ţuə		Pital	noN s) ls				<u>,                                    </u>		ntenain	urrin & Mai	erati	odO)	

FIGURE 4.6.13-3 REMOTE MAYDAY I/F, (RTS2)

\* All prices are in thousands of 1995 dollars.

### Remote Transit Fare Management (RTS3)

Quantity	State *								State *								35 dollare
Unit Price	Steady State *	37		3					Steady State *	4.8		1.8					2017 of 100
Retail Price *		ost Study	ashington	METRO and GOCARD System													* All prices are in thousands of 1005 dollars
Comparative Technology		Reference ITI Cost Study	(FHWA) and Washington	METRO and GO													*
Quantity (High)	ite *								te *								
Quantity (Low)	Introductory State *								Introductory State *								
Unit Price (High)	troduc	40		2					troduc	8.4		7					
Unit Price (Low)	<b>l</b>	28		3					u	4.8		1.8					
Years to Replacement (Life Cycle)		2		20													
Equipment Description		Ticket Vending Machine for Smart Card		Software & Integration			Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Communication Line to Electronic Payment Instrument DS0 from	Data Loading Analyses (See Common Equipment in Section 5.6)	Maintenance: Equipment @ 5% of Capital					
-		⊢			curring I Investm			)		O		tenat	gnir nisM		)erat	iO)	

FIGURE 4.6.13-4 REMOTE TRANSIT FARE MANAGEMENT, (RTS3)

### Remote Transit Security I/F (RTS4)

Quantity	state *								State *								
Unit Price	Steady State	4	2						Steady State *	4.8		0.08					
Retail Price *		tallations	v England	cts per LBA						tructure							
Comparative Technology		Existing Site Installations	Prices from New England	& Virginia Projects per LBA						Current Price Structure	from GTE						
Quantity (High)	*								*								
Quantity (Low)	Introductory State *								Introductory State *								-
Unit Price (High)	roducto	2	2.5						roducto	8.4		0.1					
Unit Price (Low)	Int	4	2						Int	4.8		0.08					1
Years to Replacement (Life Cycle)		10	10														
Equipment Description		CCTV (Interior Fixed Mount)	Integration (per Location)		(Image Processing & Video Walls performed @ Transit Center)		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Communication Line DS1 per Data Loading Analyses	(see Common Equipment in Section 5.6)	Maintenance CATV @ 2% of Capital Cost					
		<u>U</u>		uəı	misə	A-nc stiqs:		)		10		intenar	currin & Ma	iter	ıədc	<b>)</b>	

FIGURE 4.6.13-5 REMOTE TRANSIT SECURITY I/F, (RTS4)

\* All prices are in thousands of 1995 dollars.

### **4.6.14. Toll Administration Subsystem (TAS)**

This subsystem contains only one Equipment Package Toll Administration, (TAS1). This Equipment Package provides the capability to maintain database information with pricing structure information. This capability is provided through database software containing pricing structure and current traffic conditions on the transportation network obtained from the Transportation Management Center. This capability allows the determination of dynamic tolls according to congestion levels for demand management. Communications interface with wireline modem using wireline telephone is also supported. Dependent on the arrangement with the financial institutions, this Equipment Package may also contain a billing database. Wireline communications to the TMC, ISP, TMS, TRMS, and Toll Service Provider are included per the data loading analysis communication requirements as described in the common equipment section 4.6, above.

### Toll Administration (TAS1)

Unit Price Quantity	Steady State *	10	0			20		0.5	0.5	0.5	0.5	0.5	က	Steady State *			9.0		4.8		4.8		8		4.8		24
Unit	Ste	1	20			2		0.	0	0	0.	0	(,)	Ste	9		0.		4		4		4		4		0
Retail Price *			well exper. in	on Projects											<b>Current Price</b>	Structure	from GTE	-									>
Comparative Technology		486 CPU	Per Loral, Rockwell exper. in	similar Integration Projects																							
Quantity (High)	e *													*													
Quantity (Low)	Introductory State *													Introductory State													
Unit Price (High)	roducte	15	40			40		-	1	-	-	-	2	roducte	10		1.2		8.4		8.4		8.4		8.4		7
Unit Price (Low)	Int	10	20			20		0.5	0.5	0.5	0.5	0.5	က	Int	2		9.0		4.8		4.8		4.8		4.8		Č
Years to Replacement (Life Cycle)		2	10			10		20	20	20	20	20	20														
Equipment Description		486 / Pentium PC w/1 gigabyte, 2 Workstations, Printer, Modem	Software - Database (local)	Note: Software is off-the-shelf technology and unit price does	not reflect product development	National Database Coord.	Communication Line DS0 to other agencies, DMV/ Enforcement	Agency/ Financial Institution	Communication Line DS1 to ISP	Communication Line DS1 toTCS	Communication Line DS1 to TMS	Communication Line DS1 to TRMS	Communication Line DS3 to Toll Service Provider		Database Management Contract @ 10% of Capital Cost	No Additional Staff	Agency Wireline Communication DS0 per Data Loading	(see Common Equipment in Section 5.6)	ISP Wireline Communication DS1 per Data Loading	(see Common Equipment in Section 5.6)	TCS Wireline Communication DS1 per Data Loading	(see Common Equipment in Section 5.6)	TMS Wireline Communication DS1 per Data Loading	(see Common Equipment in Section 5.6)	TRMS Wireline Communication DS1 per Data Loading	(see Common Equipment in Section 5.6)	TOT CON
-		4				rin ves	սլլ	stic	Cal	lsi	_		U						uin	sМ		suo	•	<u>ت</u> Iəd	-	<u> </u>	<b> -</b>

\* All prices are in thousands of 1995 dollars.

### **4.6.15. Toll Collection Subsystem (TCS)**

This subsystem contains only one Equipment Package, Toll Plaza Toll Collection (TCS1): This Equipment Package provides existing toll plazas the capability to identify properly equipped vehicles and automatically perform toll collection with transaction confirmation. These capabilities are provided with an active tag reader and vehicle identification software running on a workstation type processor. Automated billing and notification to authorities of violations is supported using a wireline modem and telephone.

A suitable camera, sensor, software and processor system is utilized to identify violators. These are controlled or activated by sensors. The processing capability incorporates the use of either a localized data base of violators or connect directly to the TAS for access to a centralized data base of violators. At each toll location, violation detection surveillance is implemented via cameras. Full surveillance coverage includes an average of one cameras for every two lanes. Each camera is a stationary unit with magnification lenses. A series of sensors that are linked to the electronic payment systems are linked to the communication network and the software and processor for violation detection. These sensors detect violations and signal the module processor to initiate the video use, as well as the data base checks. These sensors are included in the reader system unit price.

### Toll Plaza Toll Collection (TCS1)

e Quantity	Steady State *												Steady State *										
Unit Price	Stead	2	10	2		2				0.5			Stead	0.2	0.5				4.8				
Retail Price *																			Structure				
Comparative Technology		Exist. Tech.	Lightweight	Sign Structure															Current Price Structure	from GTE			
Quantity (High)	ite *												te *										
Quantity (Low)	Introductory State *												Introductory State *										
Unit Price (High)	itroduc	2	15	10		9				_			troduc	0.5	-	0			8.4				
Uni Pric (Lov	u l	2	10	2		2				0.5			-I	0.2	0.5	0			4.8				
Years to Replacement (Life Cycle)		10	20	10		10				20													
Equipment Description		Readers (per lane)	Mainline Structure	High Speed Cameras Price Per Lane (Avg. 2 Lanes / 1 Camera)	Enforcement - included in regular operations	Database (local) & Software	Note: Software is off-the-shelf technology and unit price does	not reflect product development		Communication line DSI to TAS				Maintenance Contract (per reader) @ 10% of Capital Cost	Camera Maintenance @ 10% of Capital Cost	Database Management (local)	(Net Staff Reduction Using AVI)		TAS Wireline Communication DSI per Data Loading	(see Common Equipment in Section 5.6)			
-		ľ			mjs	εeλ	սլլ	-Re stiq	Ca	lsi	iul)			2			ıeuəı	noeg gecni	10i3		dO)	1	_

FIGURE 4.6.15-1 TOLL COLLECTION SUBSYSTEM, (TCS1)

### **4.6.16. Traffic Management Subsystem (TMS)**

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Collect Traffic Surveillance	TMS1
Distributed Road Management	TMS2
TMC Advanced Signal Control	TMS3
TMC Regional Traffic Control	TMS4
TMC Based Freeway Control	TMS5
TMC Basic Signal Control	TMS6
TMC for AHS	TMS7
TMC HOV/Reversible Lane Management	TMS8
TMC Incident Detection	TMS9
TMC Incident Dispatch Coordination/Communication	TMS10
TMC Input to In-Vehicle Signing	TMS11
TMC Multi-Modal Coordination	TMS12
TMC Probe Information Collection	TMS13
TMC Toll/Parking Coordination	TMS14
TMC Traffic Information Dissemination	TMS15
TMC Traffic Network Performance Evaluation	TMS16
Traffic Maintenance	TMS17

It is assumed that the building for the Traffic Management Center is already in place to some limited extent. There is no initial construction of a dedicated facility. The expense for the facility is in recurring expenditures of rental costs. The initial basic communication lines are in-place, and only those changes necessary to incorporate the additional capabilities are included in the analysis.

An annual rent charge of \$18.00 per square foot is assumed, with an estimated average of 250 square feet per staff member. This unit price for floor space rental equates to an additional \$4,500 to the average annual staff unit prices. Average annual staff unit prices vary according to the functions performed. Generally, it is anticipated that a base salary is multiplied by a benefits factor for overhead, overtime, other benefits, to which an additional \$4,500 is added for building rent.

The map data base is assumed to be developed by third party vendors and is purchased by the TMC. An annual update of the database for the life cycle of the database (prior to a major update) is assumed to be included in the purchase price of the database. The database area coverage includes all roads and attributes (lanes, one-way streets, speed limits, restrictions, key features, sites, buildings, etc.). An independent supplier provides data base updates.

Each Equipment Package is described below.

### 4.6.16.1 Collect Traffic Surveillance, (TMS1)

This Equipment Package collects, stores, and provides electronic access to the traffic surveillance data. The surveillance data source is the Roadside Subsystem. Wireline communications are provided in this Equipment Package which collect the information from the RS subsystem, as well as connect the information flow to the EMMS subsystem and other outside agencies. These wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.16.2 Distributed Road Management, (TMS2)

This is a virtual TMC in the sense that it manages road conditions over a very diverse area with no or limited congestion but significant weather. Added in this package capability is the communication to other TMC's and outside agencies. These wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.16.3 TMC Advanced Signal Control, (TMS3)

This Equipment Package collects route planning information and integrates and uses this information in predicting future traffic conditions and optimizing the traffic control strategy for these conditions. These capabilities are achieved through real-time communication of logged routes from an Information Service Provider on the wireline communication link. Using the same communication link, the planned control strategies can be passed back to the Information Service Provider so that the intended strategies can be reflected in future route planning. Prerequisite packages include, TMS6, TMS4, and TMS16, the latter of which allows for the implementation of the advanced signal control plans.

### 4.6.16.4 TMC Regional Traffic Control, (TMS4)

This Equipment Package provides capabilities additional to those provided by the TMC Basic Signal Control Equipment Package for analyzing, controlling, and optimizing area-wide traffic flow. These capabilities provide for wide area optimization integrating control of a network signal system with control of freeway, preferential treatment for transit vehicles and HOV, considering current demand as well as expected demand with a goal of providing the capability for signal prioritization timing and real-time traffic adaptive control integrated and consistent, avoiding conflicting controls issues. These capabilities are best provided using a Traffic Management Center (TMC) to monitor and manage freeway ramp meters and intersection traffic signals and software to process traffic information and implement traffic management measures (e.g., ramp metering, signalization, and traffic coordination between both local and regional jurisdiction). The TMC is able to communicate with other TMCs in order to receive and transmit traffic information on neighboring jurisdictions. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.16.5 TMC Based Freeway Control, (TMS5)

This Equipment Package provides the control system for efficient freeway management including integration of surveillance information with freeway road geometry, as well as vehicle control such as ramp metering, CMS, HAR. This package provides the interface to coordinated TMC Equipment Packages for information dissemination to the public. Prerequisite packages include TMS1 and TMS15. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.16.6 TMC Basic Signal Control, (TMS6)

This Equipment Package provides the capability to traffic managers to monitor and manage the traffic flow in major intersections and on major arterials for urban areas as well as alleviate traffic related problems of rural areas with the primary concern of detecting and verifying incidents and providing this information to emergency management service providers. This capability includes analyzing and reducing the collected data from traffic surveillance equipment as feedback to control processes and for control strategies. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### **4.6.16.7** TMC for AHS, (TMS7)

This Equipment Package provides the capability to exercise control over those devices utilized for AHS traffic and vehicle control. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.16.8 TMC HOV/Reversible Lane Management, (TMS8)

This Equipment Package provides the capability to manage HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals, and giving preferential treatments to HOV lanes to encourage drivers to carpool. This Equipment Package also provides the capability for access and management of reversible lane facilities, including the direction of traffic flow changes during the day, especially between the peak hours and dedication of more lanes to the congestion direction during special events. This is effected through the RS subsystem. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.16.9 TMC Incident Detection, (TMS9)

This Equipment Package provides the capability to traffic managers to detect and verify incident. This capability includes analyzing and reducing the collected data from traffic surveillance equipment, including predicted incidents and hazardous conditions. the communication lines to RS equipment utilize the lines in TMS1.

### 4.6.16.10 TMC Incident Dispatch Coordination/Communication, (TMS10)

This Equipment Package provides the capability for an incident response formulation function minimizing the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies. This package has a prerequisite of TMS9.

### 4.6.16.11 TMC Input to In-Vehicle Signing, (TMS11)

This Equipment Package provides the capability to allow traffic managers input to operation and maintenance of the roadway vehicle signing devices.

### 4.6.16.12 TMC Multi-Modal Coordination, (TMS12)

This Equipment Package provides the capability of coordination activities with various modal entities. Included in this coordination is signal control at the traffic management subsystem to provide signal priority for transit vehicles. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### **4.6.16.13** TMC Probe Information Collection, (TMS13)

This Equipment Package provides the capability to accept and process probe vehicle information. This capability is provided through the use of additional hardware and probe vehicle control and tracking software.

### 4.6.16.14 TMC Toll/Parking Coordination, (TMS14)

This Equipment Package provides the transportation management center with the capability to transform and transmit network traffic congestion information to the Toll Administration or Parking Management so that dynamic pricing for demand management is possible. Communications are supported using a wireline modem. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### **4.6.16.15** TMC Traffic Information Dissemination, (TMS15)

This Equipment Package provides the capability to disseminate incident related information to travelers, potential travelers, and private Information Service Providers. These capabilities are provided using a workstation type processor within a facility connected to traveler information providers by utilizing existing wireline links. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### **4.6.16.16** TMC Traffic Network Performance Evaluation, (TMS16)

This Equipment Package provides the capability to predict travel demand patterns to support traffic flow optimization, demand management, and incident management. This Equipment Package requires the data collected by surveillance Equipment Packages as well as input from other management subsystems including the ISP Subsystem, and Transit Management Subsystem. Output from this package flows to the PS subsystem for transportation planning. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.16.17 Traffic Maintenance, (TMS17)

This Equipment Package provides traffic maintenance facilities. Prerequisite packages include TMS1, TMS14, TMS4 and TMS15.

### Collect Traffic Surveillance (TMS1)

Quantity	State *												State *												
Unit Price	Steady		0.5	3	0.5	0.5	3	135	225				Steady State	18		9	5	24		9.0		9.0		24	
Retail Price *									well exper. in	on Projects					71170117		tructure		Structure		Structure		Structure		
Comparative Technology								Estimate	Per Loral, Rockwell exper. in	similar Integration Projects					Original Original	from GTE	Current Price Structure	from GTE	Current Price Structure	from GTE	Current Price	from GTE	Current Price	from GTE	
Quantity (High)	te *												te *												
Quantity (Low)	Introductory State *												Introductory State												
Unit Price (High)	itroduc		-	2	-	-	2	165	275				itroduc	22		0	!	72		1.2		1.2		72	
Unit Price (Low)	=		0.5	က	0.5	0.5	က	135	225				u	18		9	2	24		9.0		9.0		24	
Years to Replacement (Life Cycle)			20	20	20	20	20	20	20																
Equipment Description		Communication Lines -	from TMS to DMV & Enforcement Agency Type DS0	from TMS to RS Type DS3	from TMS to EMMS Type DS0	from RS to EMMS Type DS0	from RS to TMS Type DS3	Processor and Software	Integration		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Maintenance for Processor & Software @ 5% of Capital Cost	TWO to A gonding Winding Communication DSO from Data Londing	(see Common Equipment in Section 5.8)	<u> </u>	_	-	(see Common Equipment in Section 5.6)	RS to EMMS Wireline Communication DS0 from Data Loading	(see Common Equipment in Section 5.6)	RS to TMS Wireline Communication DS3 from Data Loading	(see Common Equipment in Section 5.6)	
			(;	uə			ul li			)iu	_				(əɔเ	_		Ma	-	suo			_		

\* All prices are in thousands of 1995 dollars.

### Distributed Road Management (TMS2)

Unit Price Quantity	Steady State *	135	225			0.5	3	Steady State *	90	45	45				9.0		24	
Retail Price *		rell exper. in	n Projects			ology Prices	ogy Prices							Structure		Structure		
Comparative Technology		Per Loral, Rockwell exper. in	similar Integration Projects			Existing Technology Prices	Existing Technology Prices							Current Price Structure	from GTE	Current Price Structure	from GTE	
y Quantity (High)	ate *							*	2									
Quantity (Low)	Introductory State *		_					Introductory State										
Unit Price (High)	ntrodu	165	275				2	ntrodu	110	55	55				1.2		72	
Unit Price (Low)		135	225			0.5	3		6	45	45				9.0		24	
Years to Replacement (Life Cycle)		10	10			20	20											
Equipment Description		Software and Integration, Installation and 1 year Maintenance	Integration with other TMCs	Note : Software is off-the-shelf technology and unit price does		Communication Line DS0 from TMC to other Agencies	Communication Line DS3 from TMC to other TMC		Operators (2 at 50% of the time at \$100 000)			Note : Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	Agency Wireline Communication DS0 from Data Loading	_	TMC Wireline Communication DS3 from Data Loading	(see Common Equipment in Section 5.6)	
		0,		etme	urring Inves	letic	Car		10			neten	urrin: & Ma	suc	_	•		

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.16-2 DISTRIBUTED ROAD MANAGEMENT, (TMS2)

### TMC Advanced Signal Control (TMS3)

Software Installation and 1 year Maintenance 5 225 275 775 Fixeliations prices    Production		Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Q Price (High)	Quantity Qua (Low) (H	antity igh)	Comparative Technology	Retail Price *	Unit Price	Quantity
Software Installation and 1 year Maintenance				Int	roductor	y State *				Steady State *	tate *
Integration   20   180   220     Hardware (1 Workstation)   5   5   10     Hardware (1 Workstation)   5   10     Hardware (1 Workstation)   5   10     Hardware (1 Workstation)   5   10     Hardware (2 Software is off-the-shelf technology and unit price does		Software Installation and 1 year Maintenance	2	22.5	27.5		Exis	sting Site Inst	allations prices	22.5	
Hardware (1 Workstation)  Properties and the shelf technology and unit price does  Note: Software is off-the-shelf technology and unit price does  Note: Software is off-the-shelf technology and unit price does  Note: Software is off-the-shelf technology and unit price does  Note: Software is off-the-shelf technology and unit price does  To closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing  This is a closed loop signal system communication is through existing thro	(1		20	180	220		fron	n Massachus	etts Highway	180	
Note: Software is off-the-shelf technology and unit price does  Note: Software is off-the-shelf technology and unit price does  not reflect product development.  Closed loop signal system communication is through existing  TMS 6 lines  Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)	uəu	Hardware	2	2	10		Dep	artment per	LBA projects	2	
Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Mote: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)		Note: Software is off-the-shalf technology and unit									
Closed loop signal system communication is through existing  Closed loop signal system communication is through existing  TMS 6 lines  Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)		not reflect product development.									
Closed loop signal system communication is through existing  TMS 6 lines  TMS 6 lines  Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)											
Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)		Closed loop signal									
Transportation Engineer (2 at \$100,000)  Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)		•									
Transportation Engineer (2 at \$100,000)  Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)  Operations  6  Operations  Operati	1iul										
Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)	)										
Transportation Engineer (2 at \$100,000)  Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)											
Transportation Engineer (2 at \$100,000)  Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)				In	roductor	y State *				Steady State	tate *
Systems Analyst (1 at 50% of the time at \$75,000)  Maintenance Contract  Maintenance Contract  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)  Opposite to the time at \$75,000 and the standard prices (Base Salary, and the standard prices)  Opposite to the time at \$75,000 and the standard prices (Base Salary, and the standard prices)  Opposite to the time at \$75,000 and the standard prices (Base Salary, and the standard prices)  Opposite to the standard prices (Base Salary, and the standard prices)  Opposite to the standard prices (Base Salary, and the standard prices)		Transportation Engineer (2 at \$100,000)		180	220					180	
Maintenance Contract Maintenance Contract Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)  Opposition	(ә	Systems Analyst (1 at 50% of the time at		34	14					34	
(Operations & Mainten	guc			06	110					06	
(Operations & Main											
Operations & Ma											
		Overtime, Overhead, Benefits,									
Operation (Operation (											
aedO)	ratio										
D)	ıəd										
	0)										

FIGURE 4.6.16-3 TMC ADVANCED SIGNAL CONTROL, (TMS3)

### TMC Regional Traffic Control (TMS4)

Quantity	tate *							* ate										
Unit Price (	Steady State	135	225			0.5	3	Steady State	06	45	45				9.0		24	
Retail Price *		well exper. in	n Projects			nology Prices	logy Prices							Structure		Structure		
Comparative Technology		Per Loral, Rockwell exper. in	similar Integration Projects			Existing Technology Prices	Existing Technology Prices							Current Price Structure	from GTE	Current Price Structure	from GTE	
Quantity (High)	ite *							*	2									
Quantity (Low)	Introductory State *							Introductory State										
Unit Price (High)	troduct	165	275			~	2	froding	110	22	22				1.2		72	
Unit Price (Low)	ln	135	225			0.5	3	2	06	45	45				9.0		24	
Years to Replacement (Life Cycle)		10	10			20	20											
Equipment Description		Software and Integration, Installation and 1 year Maintenance	Integration with other TMCs	Note : Software is off-the-shelf technology and unit price does	not reflect product development.	Communication Line DS0 from TMC to other Agencies	Communication Line DS3 from TMC to other TMC		Operators (2 at 50% of the time, at \$100,000)	Transporation Engineer (1 at 50% of the time, at \$100,000)	Maintenance Contract	Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	Agency Wireline Communication DS0 from Data Loading	(see Common Equipment in Section 5.6)	TMC Wireline Communication DS3 from Data Loading	(see Common Equipment in Section 5.6)	
		<u>, 0, 1</u>		ıəmtə	sə∧u	-Recu Dital I	Cap		10	_		neter	urrin & Ma	suo				

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.16-4 TMC REGIONAL TRAFFIC CONTROL, (TMS4)

### TMC based Freeway Control (TMS5)

Quantity	State *									State *										
Unit Price	Steady State *	180	15					0.5		Steady State	4.8			90		135				
Retail Price *		tallations	v England	jects per LBA				ology			tructure			tallations	v England	and Virginia Projects per LB,				
Comparative Technology		Existing Site Installations	Prices from New England	and Virginia Projects per LBA				Existing Technology			Current Price Structure	from GTE		Existing Site Installations	Prices from New England	and Virginia F				
Quantity (High)	<b>.</b>									*										
Quantity (Low)	Introductory State *									Introductory State *										
Unit Price (High)	troduct	220	30					-		troduct	8.4			110		165				
Unit Price (Low)	<u>=</u>	180	15					0.5		Ī	4.8			06		135				
Years to Replacement (Life Cycle)		2	2					20												
Equipment Description		Software and Integration, Installation and 1 year Maintenance	Hardware (3 Workstations)		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		TMC To RS Communication Line; DS1 Type			Wireline Communication DS1 from Data Loading	(see Common Equipment in Section 5.6)		Operators (2 @ 50% of the Time, @ \$100,000)		Maintenance Technicians (2 @ \$75,000)	Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)		
		<u>, ~, </u>		uəi	mjs		noeЯ ital li	Cap	II)				ieuə:	uir			ioijs:	ıəd	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.16-5 TMC BASED FREEWAY CONTROL, (TMS5)

### TMC Basic Signal Control (TMS6)

Quantity	State *									State *											
Unit Price	Steady State *	180	15					0.5		Steady State	4.8		06	45		216	135				
Retail Price *		tallations	v England	jects per LBA				logy			tructure		tallations	v England	jects per LBA						
Comparative Technology		Existing Site Installations	Prices from New England	and Virginia Projects per LBA				Existing Technology			Current Price Structure	from GTE	Existing Site Installations	Prices from New England	and Virginia Projects per LBA						
Quantity (High)	te *									te *											
Quantity (Low)	Introductory State *									Introductory State											
Unit Price (High)	troduci	220	30					-		troduc	8.4		110	22		264	165				
Unit Price (Low)	드	180	15					0.5		<u>-</u>	4.8		06	45		216	135				
Years to Replacement (Life Cycle)		2	2					20		_											
Equipment Description		Software and Integration, Installation and 1 year Maintenance	Hardware (3 Workstations)		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		TMC To RS Communication Line; DS1 Type			Wireline Communication DS1 from Data Loading	(see Common Equipment in Section 5.6)	Operators (2 @ 50% of the Time, @ \$100,000)	Transportation Engineer (1 at 50% of the time, at \$100,000)		systems)	Signal Maintenance Technicians (2 @ \$75,000)	Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)		
				uə	mjs		Recu lital li	Cap	)		<u> </u>		eusı	ļui			suo		ıəd	<b>)</b>	

\* All prices are in thousands of 1995 dollars.

### TMC for AHS (TMS7)

		Software Installation a	Integration	ıuəı			TMS to RS	İnitial Ca <u>k</u>		Transportation Engineers (5 at \$100,000)	System Maintenance	Technicians (2 at \$75,000)	Note: Salary Costs are fully loaded prices	Overtime, Overhead,	-	(see Common Equipment in Section 5.	
Equipment Description		Software Installation and 1 year Maintenance			Note: Software is off-the-shelf technology and unit price does	not reflect product development.	Communication Line; DS0 Type			ers (5 at \$100,000)	@ 5% of Capital Cost	(000)	e fully loaded prices (Base Salary,	head, Benefits, etc.)	RS Wireline Communication DS0 from Data Loading	(9)	
Years to Replacement (Life Cycle)		5	20				20										
Unit Price (Low) (	Intro	45	225				0.5		Intro	450	12	135			9.0		_
Unit Qua Price (L	Introductory State *	22	275				-		Introductory State	550	17	165			1.2		
Quantity Quantity (Low)	State *								State *								
y Comparative Technology		Estimate Per Loral, Rockwell	Experience in Similar	Integration Projects			Existing Technology			Phase 1 Document Review	Average Price Ranges				Current Price Structure	from GTE	
Retail Price *		oral, Rockwell	Similar	ects			ınology			nent Review	Ranges				Structure		
Unit Price	Steady State *	45	225				0.5		Steady State	450	12	135			9.0		
Quantity	State *								State *								

\* All prices are in thousands of 1995 dollars.

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### TMC HOV/Reversible Lane Management (TMS8)

Introductory State   Introdu		Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
Software Development and Integration				Iní	troduct	ory Stat	* 9			Steady 8	State *
Hardware (1 Workstation)   5 2.7 3.3   Institutions   1.7   1.2   1.3   Institutions   1.2   Institutions   1.3   Institutions   Institu		Software Development and Integration	10	180	220			Existing Site		180	
19' Monitor Software Upgrade for Controllers	(1	Hardware (1 Workstation)	2	2.7	3.3			Installations		2.7	
Software Upgrade for Controllers   Software Upgrade for Controllers   Software Upgrade for Controllers   Software Upgrade for Controllers   Software Development is fine tune adjustments for local installations.   Software Development is fine tune adjustments for local installations.   Software Development is fine tune adjustments for local installations.   Software is off-the-shelf technology and unit price does   Projects per   Direction P	uə	19" Monitor	2	2.7	3.3			Prices from		2.7	
Software Development is fine tune adjustments for local installations.   Software Development is fine tune adjustments for local installations.   Software Development is fine tune adjustments for local installations.   Software is off-the-shelf technology and unit price does   LBA		Software Upgrade for Controllers	က	45	22			New England		45	
Software Development is fine tune adjustments for local installations.   Software Development is fine tune adjustments for local installations.   Software Development is fine tune adjustments for local installations.   LBA   Direction Color Col								and Virginia			
Communication Line; DS1 Type   Communication DS1								Projects per			
The communication Line; DS1 Type   Dos		Software is off-the-shelf technology and						LBA			
TMS to RS Communication Line; DS1 Type   20 0.5 1   Existing Technology   0.5		not reflect product development.									
Common Equipment in Section 5.6)   Common Equipme	iţiu	to RS Communication Line; DS1	20	0.5	-			Existing Techno	logy	0.5	
Operator (2 for 4 hours each, at \$100,000 for 8 hours)     90 110       Maintenance of Equipment @ 5% of Capital Cost     12 14       Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)     12 14       Maintenance of Equipment (Broading)     12 14       Maintenance of Equipment (Broading)     13 14       Maintenance of Equipment (Broading)     14 18 14 14       Maintenance of Equipment (Broading)     15 14 14       Maintenance of Equipment (Broading)     16 14 18 18 18 18 18 18 18 18 18 18 18 18 18				2	to die	50 V.	*			Stoody (	
Operator (2 for 4 hours each, at \$100,000 for 8 hours)       90       110         Maintenance of Equipment @ 5% of Capital Cost       12       14         Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)       Assistance of Equipment (Salary)         Maintenance of Equipment (Salary)       Assistance of Equ			_		noancı	ory Stat	D.			Steady	
Maintenance of Equipment © 5% of Capital Cost  Note : Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)  Maintenance of Equipment © 5% of Capital Cost  Overtime, Overhead, Benefits, etc.)  Maintenance of Equipment © 5% of Capital Cost are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)  Maintenance of Equipment © 5% of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary,  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Maintenance of Capital Cost are fully loaded prices (Base Salary)  Main		Operator (2 for 4 hours each, at \$100,000 for 8 hours)		90	110					06	
Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)  May a large of the communication DS1 from Data Loading (see Common Equipment in Section 5.6)  See Common Equipment in Section 5.6)  Output  Details are fully loaded prices (Base Salary, and a large of the common Equipment in Section 5.6)  Output  Details are fully loaded prices (Base Salary, and a large of the common Equipment in Section 5.6)  Output  Details are fully loaded prices (Base Salary, and a large of the common Equipment in Section 5.6)  Output  Details are fully loaded prices (Base Salary, and a large of the common Equipment in Section 5.6)  Output  Details are fully loaded prices (Base Salary, and a large of the common Equipment in Section 5.6)	(ə	Maintenance of Equipment @ 5% of Capital Cost		12	14					12	
A RS Wireline Communication DS1 from Data Loading (see Common Equipment in Section 5.6)	วนะ	Note: Salary Costs are fully loaded prices (Base Salary,									
RS Wireline Communication DS1 from Data Loading 4.8 8.4 Current Price Structure (see Common Equipment in Section 5.6) from GTE		Overtime, Overhead, Benefits, etc.)									
See Common Equipment in Section 5.6    A.8 Wireline Communication DS1 from Data Loading   A.8 Wireline Common Equipment in Section 5.6											
(See Common Equipment in Section 5.6)		DS1 from Data Loadin		8.8	8.4			Current Price	Structure	4.8	
odo)		Section 5						from GTE			
	qO)										

FIGURE 4.6.16-8 TMC HOV/REVERSIBLE LANE MANAGEMENT, (TMS8)

### TMC Incident Detection (TMS9)

Harrdware (4 Servers)   Full Action (4 Analysts @ \$100,000 and 1 Manager @ \$150,000     Analysts @ \$100,000 and 1 Manager @ \$100,000		Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
Hardware (4 Servers)   Hardware (4 Servers)   Hardware (5 Servers)   Hardware (5 Workstations)   5 55 50   Metropolitan Soston ITS				Int	roducto	ory State	*			Steady 8	
Hardware (5 Workstations)   5 5 50   Metropolitan Boston ITS		Hardware (4 Servers)	5	54	99			Existing Site Ins	stallations	54	
Software (off-the-shelf and developed)	(1	Hardware (5 Workstations)	2	22	20			Metropolitan Bo	ston ITS	25	
Integration	uə	Software (off-the-shelf and developed)	5	06	110			Phase 1 Deploy	/ment and	06	
13.5 Fig. 5   16.5   16.5   19.5   16.5   19.5   16.5   19.5   16.5   19.5   16.5   19.5   16.5   19.5   16.5   19.5	mjs	Integration	20	06	110			MHD Central A	rtery CANA	06	
19° Video Monitors (5) Video Wall (3x3=9 monitors wivideo switch, etc.)  Communication Line Utilizes TMS1 Line  Introductory State*  Existing Site Installations  Metropolitan Boston ITS  Phase 1 Deployment and  MHD Central Artery CANA  Incident Management  Project per LBA  Maintenance Technicians (2) (@ \$75,000)  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)	εeλ	Laser Printer (2)	2	2.7	3.3			Incident Manage	ement	2.7	
Video Wall (3x3=9 monitors w/video switch, etc.)         5         27         33           Communication Line Utilizes TMS1 Line         Introductory State*         Existing Site Installations           Operators (4 Analysts @ \$100,000 and 1 Manager @ \$150,000)         495         605         Existing Site Installations           Operators (4 Analysts @ \$100,000 and 1 Manager @ \$150,000)         495         605         Metropolitan Boston ITS           Maintenance Technicians (2) (@ \$75,000)         15         20         Project per LBA           Maintenance Technicians (2) (@ \$75,000)         135         165         Project per LBA           Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overtime, Overtime, Overtime, Step.)         15         20         Project per LBA	u	19" Video Monitors (5)	2	13.5	16.5			Project per LE	3A	13.5	
Communication Line Utilizes TMS1 Line         Introductory State*         Existing Site Installations           Operators (4 Analysts @ \$100,000 and 1 Manager @ \$150,000)         495 605         Existing Site Installations           Operators (4 Analysts @ \$100,000 and 1 Manager @ \$150,000)         495 605         Existing Site Installations           Operators (4 Analysts @ \$100,000 and 1 Manager @ \$150,000)         Metropolitan Boston ITS         Phase 1 Deployment and Metropolitan Boston ITS           AM for Equipment (Hardware and Software) @ 5% of Capital Cost         15 20         Project per LBA           Maintenance Technicians (2) (@ \$75,000)         135 165         Project per LBA           Note : Salary Costs are fully loaded prices (Base Salary, Overtime, Overthead, Benefits, etc.)         135 165         Project per LBA	etiqe		2	27	33					27	
Introductory State *   Interval State *   Introductory State *   I	O IsitinI)	Communication Line Utilizes TMS1 Line									
Operators (4 Analysts @ \$100,000 and 1 Manager @ \$150,000)         \$150,000)         495         605         Existing Site Installations           Metropolitan Boston ITS         Metropolitan Boston ITS         Phase 1 Deployment and MIND Central Artery CANA         MIND Central Artery CANA           O&M for Equipment (Hardware and Software) @ 5% of Capital Cost         15         20         Project per LBA           Maintenance Technicians (2) (@ \$75,000)         135         165         Analysis are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)         Applead to the standard of the stan				lut	roducto	ory State	*			Steady 9	State *
Metropolitan Boston ITS Phase 1 Deployment and MHD Central Artery CANA Incident Management O&M for Equipment (Hardware and Software) @ 5% of Capital Cost Maintenance Technicians (2) (@ \$75,000) Maintenance Technicians (2) (@ \$75,000) Note : Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)		@ \$100,000 and 1 Manager @		495	605			Existing Site Ins	stallations	495	
Phase 1 Deployment and MHD Central Artery CANA Incident Management Anintenance Technicians (2) (@ \$75,000)  Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overtead, Benefits, etc.)	(ә							Metropolitan Bo	oston ITS		
O&M for Equipment (Hardware and Software) @ 5% of Capital Cost         15         20         MHD Central Artery CANA           O&M for Equipment (Hardware and Software) @ 5% of Capital Cost         15         20         Project per LBA           Maintenance Technicians (2) (@ \$75,000)         135         165         Analysis           Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)         Analysis         Analysis	วนเ							Phase 1 Deploy	/ment and		
O&M for Equipment (Hardware and Software) @ 5% of Capital Cost 15 20 Project per LBA  Maintenance Technicians (2) (@ \$75,000)  Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overthead, Benefits, etc.)	euə							MHD Central A	rtery CANA		
O&M for Equipment (Hardware and Software) @ 5% of Capital Cost       15       20       Project per LBA         Maintenance Technicians (2) (@ \$75,000)       135       165       165         Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)       0       135       165	<u> </u>							Incident Manage	ement		
O&M for Equipment (Hardware and Software) @ 5% of Capital Cost       15       20         Maintenance Technicians (2) (@ \$75,000)       135       165         Note: Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)       Annual Salary Costs are fully loaded prices (Base Salary, Overtime, Overhead, Benefits, etc.)	eMa							Project per LBA			
Maintenance Technicians (2) (@ \$75,000)  Note: Salary Costs are fully loaded prices (Base Salary,  Overtime, Overhead, Benefits, etc.)	<b>7</b> 8 5	9		15	20					15	
Note: Salary Costs are fully loaded prices Overtime, Overhead, Benefits, etc.)	tions			135	165					135	
	bera	Note : Salary Costs are fully loaded prices (Base Salary,									
	0)	Overtime, Overhead, Benefits, etc.)									

\* All prices are in thousands of 1995 dollars.

# TMC Incident Dispatch Coordination/Communication (TMS10)

Quantity	State *													State *											
Unit Price	Steady State	2.7	13.5	2.7	180					0.5				Steady State	06	_				9	0.0				
Retail Price *										ology					stallations	w England and	s per LBA			Ottribolito	Siluciula				
Comparative Technology		Existing Site	Installations	Prices from	New England	and Virginia	Projects per	LBA		Existing Technology					Existing Site installations	Prices from New England and	Virginia Projects per LBA			Orintourity Coiro		from GTE			
Quantity (High)	te *													te *											
Quantity (Low)	Introductory State *													Introductory State *											
Unit Price (High)	troduct	3.3	16.5	3.3	220					-				troduct	110	1.2				, C	- -				
Unit Price (Low)	ln	2.7	13.5	2.7	180					0.5				п	06	_				9	0.0				
Years to Replacement (Life Cycle)		2	2	5	20					20				-	-										
Equipment Description		Hardware (1 Workstation)	Software	19" Monitor	Integration		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		TMC to EM Communication Line; DS0 Type					Incident Management Coordinator (1 @ \$100,000)	Equipment Maintenance @ 5% of Capital Cost	Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	Shortwave Radio Access (No Additional Cost)			(see Common Equipment in Section 5.6)	Emergency Traffic Management Staff not Included		
		<u></u>			mjs		սլլ	a Pi-Resting	БЭ	tial	I)	-	I.		<u>. —</u>				urring Mair	8 su	oi			1	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.16-10 TMC INCIDENT DISPATCH COORDINATION/COMMUNICATION, (TMS10)

### TMC Input to In-Vehicle Signing (TMS11)

Quantity	, State *									Steady State *										_
Unit Price	Steady State	45	18							Steady	45	6	13.5							
Retail Price *		oral, Rockwell	imilar	ects																
Comparative Technology		Estimate Per Loral, Rockwell	Experience in Similar	Integration Projects																
Quantity (High)	te *									te *										
Quantity (Low)	Introductory State *									Introductory State *										
Unit Price (High)	roduct	22	22							roduct	22	11	16.5							
Unii Prio	Int	45	18							Int	45	6	13.5							
Years to Replacement (Life Cycle)		20	2																	
Equipment Description		Integration	Software Installation and 1 year Maintenance		Note: Software is off-the-shelf technology and unit price does						Operator (1 for 4 hours per day at \$100,000)	Weather Advisory Reporting	Shortwave Communication to Beacons	No Other Additional Staff as Operations are Automated	Note : Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)				_
		_		uəı	mjs	eλu	Recu Ital II		uĮ)					uəju	_		isti	ədo	)	_

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.16-11 TMC INPUT TO IN-VEHICLE SIGNING, (TMS11)

### TMC Multi-Modal Coordination (TMS12)

Introductory State * Integration and 1 year Maintenance   20   18   22   Estimate Per Loral, Rockwell   90   110   Experience in Similar   18   18   18   18   18   18   18   1	Equipment Description	Replacement (Life Cycle)	Price (Low)	Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
20   90   110   Estimate Per Loral, Rockwell   20   18   22   Experience in Similar   Integration Projects   20   0.5   1   Existing Technology   20   0.5   1   Existing Technology   20   20   20   20   20   20   20   2			ln	troduct	ory Stat	е *			Steady 8	state *
does  does  20	Integration	20	06	110			Estimate Per Lo	ıral, Rockwell	06	
Integration Projects	ire Installation and 1 year Maintenance	20	18	22			Experience in S	imilar	18	
135   1   Existing Technology   135   165   1							Integration Proje	ects		
Introductory State *	Note: Software is off-the-shelf technology and unit price does									
20 0.5 1 Existing Technology  Introductory State * 135 165	not reflect product development.									
20 0.5 1 Existing Technology  Introductory State *  135 165  4.8 8.4 Current Price Structure from GTE										
Introductory State *  135 165  4.8 8.4 Current Price Structure from GTE	o TRMS Communication Line; DS1 Type	20	0.5	-			Existing Tech	nology	0.5	
Introductory State *   135 165   1										
Introductory State *   135 165   165     165										
Introductory State *   135 165   1										
Introductory State *  135 165  4.8 8.4 Current Price Structure from GTE										
Introductory State *										
135 165   16			lu	troduct	ory Stat	*			Steady (	State *
4.8 8.4 Current Price Structure from GTE	@		135	165					135	
4.8 8.4 Current Price Structure from GTE	Salary Costs are fully loaded prices (Base Salary									
4.8 8.4 Current Price Structure from GTE	Overtime, Overhead, Benefits, etc.)									
4.8 8.4 Current Price Structure from GTE										
Section 5.6)	TRMS Wireline Communication DS1 from Data Loading		4.8	8.4			Current Price Si	tructure	4.8	
	(see Common Equipment in Section 5.6)						from GTE			

FIGURE 4.6.16-12 TMC MULTI-MODAL COORDINATION, (TMS12)

### TMC Probe Information Collection (TMS13)

Integration   Software Installation and 1 year Maintenance   Software (1 Workstation)   Software is off-the-shelf technology and unit price does   not reflect product development.   Initial   In	20 135 20 136 3 3 5 5 18 18 18 18 18 18 18 18 18 18 18 18 18	Introductory State * 165	tate *				
Integration Software Installation and 1 year Maintenance Hardware (1 Workstation) Note: Software is off-the-shelf technology and unit price does not reflect product development.						Steady State *	tate *
Software Installation and 1 year Maintenance Hardware (1 Workstation)  Note: Software is off-the-shelf technology and unit price does not reflect product development.				Estimate Per Loral, Rockwell	al, Rockwell	135	
Hardware (1 Workstation)  Note: Software is off-the-shelf technology and unit price does not reflect product development.		01		Experience in Similar	nilar	18	
Note: Software is off-the-shelf technology and unit not reflect product development.				Integration Projects	cts	2	
più linitial Cap							
ijinl)							
		Introductory State	State *			Steady State	tate *
Operator (1 for 4 hours per day at \$100,000)	45	55				45	
Maintenance for Power, Servicing and Repair							
(10% of Capital Cost)	16	19				16	
ua)							
0.51							
ıoite							
uad.							

FIGURE 4.6.16-13 TMC PROBE INFORMATION COLLECTION, (TMS13)

### TMC Toll/Parking Coordination (TMS14)

	Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity G (Low) (	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
			Int	roducto	Introductory State *	*			Steady State *	State *
	Software Installation and 1 year Maintenance	2	22.5	27.5			Estimate Per Loral, Rockwell	ral, Rockwell	22.5	
(1	Integration	20	90	110			Experience in Similar	imilar	06	
uə							Integration Projects	ects		
	Note: Software is off-the-shelf technology and unit price does									
	not reflect product development.									
Recu Ital I	TMC to PMS Communications Line: DS1 Type	20	0.5	-			Existina Technoloav	nology	0.5	
		000	5.0	-			Existing Technology	loav	2.0	
N ) (sitinl)										
		_	重	roducto	Introductory State	*			Steady State *	State *
	Maintenance @ 5% of Capital Cost		9	7					9	
(əɔuı	PMS Wireline Communication DS1 from Data						Current Price Structure	tructure		
euə	Loading (see Common Equipment in Section 5.6)		4.8	8.4			from GTE		4.8	
	•						Current Price Structure	tructure		
Recurrin SM & Ma	Loading (see Common Equipment in Section 5.6)		9.0	1.2			from GTE		0.6	
perati										
O)										
		-					* All p	* All prices are in thousands of 1995 dollars.	sands of 199	5 dollars.

.

### TMC Traffic Information Dissemination (TMS15)

Equipment Description Replacement			) titud	Organity	Comparative			
	ment Price	Price (High)	(Low)	(High)	Technology	Retail Price *	Unit Price	Quantity
		Introductory State *	tory Stat	*			Steady State *	State *
3	2	10			Existing Site Installations	stallations	2	
3	18	22			Prices from New England	v England	18	
20	06	110			and Virginia Projects per LBA	ojects per LBA	06	
Note : Software is off-the-shelf technology and unit price does								
not reflect product development.								
TMC to Event Communications Line; DS0 Type	0.5	_			Existing Technology	ology	0.5	
TMC to ISP Communications Line; DS3 Type	3	2			Existing Technology	ology	3	
		Introductory State	tory Stat	*			Steady State	State *
	06	110					06	
Note: Salary Costs are fully loaded prices (Base Salary,								
Benefits, etc.)								
5% of Capital Cost	2	7					2	
	0	0						
SP Wireline Communication DS3 from Data					Current Price Structure	Structure		
Loading (see Common Equipment in Section 5.6)	24	72			from GTE		24	
Other Wireline Communication DS0 from Data					<b>Current Price</b>	Structure		
Loading (see Common Equipment in Section 5.6)	9.0	1.2			from GTE		9.0	
	+	-						

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.16-15 TMC TRAFFIC INFORMATION DISSEMINATION, (TMS15)

# TMC Traffic Network Performance Evaluation (TMS16)

Quantity	tate *								tate *									
Unit Price	Steady State	13.5	450	180	180	က			Steady State	450			23			24		
Retail Price *		ral, Rockwell	imilar	ects		nology									Structure			
Comparative Technology		Estimate Per Loral, Rockwell	Experience in Similar	Integration Projects		Existing Technology									Current Price Structure	from GTE		
Quantity (High)	te *								te *									
Quantity (Low)	Introductory State *								Introductory State									
Unit Price (High)	troduct	16.5	550	220	220	2			troduct	220			28			72		
Unit Price (Low)	ב	13.5	450	180	180	ဗ			ľ	450			23			24		
Years to Replacement (Life Cycle)		2	2	20	20	50												
Equipment Description		Hardware (5 Workstations)	Software (Off-the-shelf and developed)	Integration with other Servers at TMC	Integration with ISP and TMS	TMC TO PS Communication Line; DS3 Type				Transportation Engineers / Analysts (5 at avg. \$100,000)	Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	Maintenance of system components @ 5% of Gapital Cost		PS Wireline Communication DS3 from Data	Loading (see Common Equipment in Section 5.6)		
		<u>                                     </u>		_	mjs	scurrin Al Inve		ıj)		<u>                                     </u>		าลทင	ıəşu	urring 8. Mai			<b>)</b>	_

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.16-16 TMC TRAFFIC NETWORK PERFORMANCE EVALUATION, (TMS16)

### Traffic Maintenance (TMS17)

Unit Price Quantity	Steady State *	20								Steady State *	06									
Retail Price * Unit	St									<i>™</i>										
Comparative R Technology		Estimate per LBA																		
Quantity (High)	* •									*										
Quantity (Low)	Introductory State *									Introductory State *										
Unit Price (High)	troduct	40								troduct	110									
Unit Price (Low)	ını	20								<u>2</u>	06									
Years to Replacement (Life Cycle)		2																		
Equipment Description		Software and Database Add-on to TMS5 & TMS6	Communication I in a to TAS through TMS1 & TMS11	Communication Line to TMC's through TMS4	Communication Line to ISP through TMS1 & TMS15			Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Additional Staff - 1 Transportation Engineer @ \$100,000	Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)							
		ינט	_	əwş	səvi	Recu Ital Ir					14		รมด	uəşı	ring Nair		ije.	ədo	<b>)</b>	_

FIGURE 4.6.16-17 TRAFFIC MAINTENANCE, (TMS17)

\* All prices are in thousands of 1995 dollars.

### **4.6.17. Transit Management Subsystem (TRMS)**

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Fleet Maintenance Management	TRM1
Transit Center Fare and Load Management	TRM2
Transit Center Fixed-Route Operations	TRM3
Transit Center Multi-Modal Coordination	TRM4
Transit Center Paratransit Operations	TRM5
Transit Center Security	TRM6
Transit Center Tracking and Dispatch	TRM7

The Transit Management Subsystem (TRMS) is the centralized control center for providing transit planning, scheduling, operation planning, personnel scheduling, and maintenance scheduling, and paratransit interface. The architecture is designed to allow one center to provide services to any number of independent public transit operators, or to accommodate multiple interconnected centers. The information generated from each operator is centrally managed by the Transit Management Center. This information is in turn shared with the TMC, ISP and PS subsystems to provide complete public transportation information.

In the cost estimate, a Transit Management Center exists. This existing center performs non-ITS operations, scheduling and other planning activities. It is assumed that the physical structure that houses the operations staff, maintenance personnel, and equipment is in-place. It is also assumed that the maintenance staff, public transport vehicle operators, paratransit operators, dispatchers and other operations staff are already in-place, and would exist as a public transit expense without the introduction of ITS. Only the incremental expense of incorporating ITS functions is included in the cost analysis.

It is assumed that the basic communication lines are in-place, and that only those changes necessary to incorporate the additional capabilities are included. The Non-recurring expense is attributable to hardware required to implement the communication system. The Recurring expense is attributable to the dedicated line charges as required capacity is noted from the data loading analysis. Previous detail on this wireline and wireless communication expenditures is located in section 4.6 under common equipment.

Each Equipment Package is described below.

### **4.6.17.1** Fleet Maintenance Management, (TRM1)

This Equipment Package provides the capability to use vehicle mileage data to automatically generate preventative maintenance schedules for each specific vehicle by utilizing vehicle tracking data from the prerequisite tracking Equipment Package (TRM7). In addition, capability to automatically ensure that proper service personnel are provided information for maintenance activities and to record and verify that maintenance work was performed is

provided. These capabilities are performed utilizing fleet management software. This package tracks and processes maintenance records for each vehicle, balances the maintenance schedule with the operation schedule, as well as performs scheduling activities for maintenance and operations staff. Components include software and processor, communication links, operations building, staff and maintenance staff. It is assumed that the maintenance staff and operation staff are already included in the No ITS Baseline. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.17.2 Transit Center Fare and Load Management, (TRM2)

This Equipment Package provides the capability to accept collected data required to determine accurate ridership levels and implement variable and flexible fare structures. Support is provided for the traveler for use of a fare medium for all applicable surface transportation services, to pay without stopping, have payment media automatically identified as void and/or invalid and eligibility verified, and allow for third party payment. In addition, capability to provide expansion into other uses for payment medium such as retail and telephone and for off-line billing for fares paid by agencies is supported. This Equipment Package also supports the capability for two-way voice communication between the transit vehicle driver and a facility, two-way data communication between the transit vehicles and a facility, sensor data to be transmitted from the transit vehicles to a facility, and data transmission from individual facilities to a central facility for processing/analysis if desired. These capabilities are provided through a workstation type processor with GUI, high capacity storage, ride share software housed in a building with dialup lines and wireline telephone as provided in the prerequisite packages TRM3 and TRM7. Additional communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.17.3 Transit Center Fixed-Route Operations, (TRM3)

This Equipment Package provides the capability to automate the planning and scheduling, allowing improvements in fixed-route routes and services to develop, printing and disseminating schedules, and automatically updating customer service operator systems with the most current schedule. In addition, this package provides the capability to assign drivers to routes in a fair manner while minimizing labor and overtime services, including driver preferences and qualifications, and automatically tracking and validating the number of work hours performed by each individual driver. These capabilities are provided through the utilization of dispatch and fleet management software running on a workstation type processor, located in package TRM7. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.17.4 Transit Center Multi-Modal Coordination, (TRM4)

This Equipment Package provides the transit management subsystem the capability to determine the need for transit priority on routes and at certain intersections and request transit

vehicle priority at these locations. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.17.5 Transit Center Paratransit Operations, (TRM5)

This Equipment Package provides the capability to automate the planning and scheduling, allowing improvements in paratransit routes and services to develop, printing and disseminating schedules, and automatically updating customer service operator systems with the most current schedule. In addition, this package provides the capability to assign drivers to routes in a fair manner while minimizing labor and overtime services, including driver preferences and qualifications, and automatically tracking and validating the number of work hours performed by each individual driver

The package facilitates other processes providing responses to overall travel demands that are outside the realm of regularly scheduled public transit services. The components include software and processor, a display, a transceiver, communications links, operations building, staff and maintenance. Communication wirelines are included in TRM7.

### 4.6.17.6 Transit Center Security, (TRM6)

This Equipment Package provides the capability to monitor key transit locations and transit vehicles with both video and audio systems automatically alerting operators and police of potential incidents and supporting traveler activated alarms. The monitoring equipment also include capabilities to assist in responding to terrorist incidents. Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.17.7 Transit Center Tracking and Dispatch, (TRM7)

This Equipment Package provides the capabilities for monitoring transit vehicle locations in real time and determining vehicle schedule adherence. In addition, capability to determine optimum scenarios for schedule adjustment is provided. The package also furnishes users with real-time travel related information, continuously updated with real-time information from each transit system within the local area of jurisdiction, inclusive of all transportation modes, from all providers of transportation services, and provide users with the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents conditions, weather conditions, and special events. This package also supports the capability for two-way voice communication between the transit vehicle driver and a facility, two-way data communication between the transit vehicles and a facility.

A dedicated processor is required with sufficient memory to store all incoming processed sensors, and data, to determine public transit vehicle traffic management strategies, planning vehicle operations and scheduling. The software and processor also provides data base information to the TMC. Operator stations are required with monitors and input keyboards.

Communication wirelines are sized according to the data loading analysis, as described in the common equipment section 4.6, above.

### Fleet Maintenance Management (TRM1)

urring Investment) Note	-	Replacement (Life Cycle)	Price (Low)	Price (High)	Quantity (Low)	Quantity (High)	Comparative	Retail Price *	Unit Price	Quantity
(Juəmtəəvni			Int	Introductory State *	ory Stat	*			Steady State *	State *
(Juəmtsəvni	ntegration	20	100	200			Per Loral, Rockwell	well	100	
nestmen	Processor / Software Upgrades	20	20	40			Experience in similar	milar	20	
misəvni							Integration Projects	ects		
	e : Software is off-the-shelf technology and unit price does									
	not reflect product development.									
Įŧ										
stiq	Communication Line DS1 Maintenance	20	0.5	_					0.5	
sO lsi	Maintenance Facility Communications Line; DS1 Type									
ļiu										
l)										
			Int	Introductory State	ory Stat	е *			Steady State	State *
	Maintenance for System @ 2% of Capital Cost		2.4	4.8					2.4	
- 1 -	Wireline Communication DS1 from Data Loading		4 8	δ.			Current Price Structure	mictire	4.8	
_	Gille Collinianication DOI Holl Data Ecodoling		) F	t 5			LHO SECTIONS		o F	
ring Mainte							5			
erat										
dO)										

FIGURE 4.6.17-1 FLEET MAINTENANCE MANAGEMENT, (TRM1)

## Transit Center Fare and Load Management (TRM2)

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.17-2 TRANSIT CENTER FARE AND LOAD MANAGEMENT, (TRM2)

### Transit Center Fixed-Route Operations (TRM3)

Quantity	State *									Steady State *									
Unit Price	Steady State	225	20		3	0.5				Steady	202			0.4	24		4.8		
Retail Price *		well	imilar	ects											Structure		Structure		
Comparative Technology		Per Loral, Rockwell	Experience in similar	Integration Projects											Current Price Structure	from GTE	Current Price Structure	from GTE	
Quantity (High)	te *									te *									
Quantity (Low)	Introductory State *									Introductory State *									
Unit Price (High)	troduct	200	40		2	-				troduci	247			0.8	72		8.4		
Unit Price (Low)	드	225	20		က	0.5				u l	202			0.4	24		4.8		
Years to Replacement (Life Cycle)		20	20		20	20													
Equipment Description		Integration	Processor/Software Upgrade, Installation and 1 yr. Maintenance		Communication DS3 Line to Operations	Communication DS1 Line to Operations		Note : Software is off-the-shelf technology and unit price does	not reflect product development.		Add'l. Staff (3) Salary and Benefits @ \$75,000 each average	Note : Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	Maintenance for Processor @ 2% of Capital Cost	Operations Wireline Communication DS3 from Data	Loading (see Common Equipment in Section 5.6)	Operations Wireline Communication DS1 from Data	Loading (see Common Equipment in Section 5.6)	
			(1	uəı		eλu	uoA-noM Il IstiqaD Isitir	11)				(əɔuɐ				erati			

\* All prices are in thousands of 1995 dollars.

### Transit Center Multi-Modal Coordination (TRM4)

Quantity	State *												State *												
Unit Price	Steady State *	06	18				2	0.5	0.5	0.5		3	Steady State	0.4	0.2	9.0		4.8		4.8		24			
Retail Price *		ral, Rockwell	imilar	ects			nology	nology	logy	logy		nology				ructure		tructure		Structure		Structure			
Comparative Technology		Estimate Per Loral, Rockwell	Experience in Similar	Integration Projects			Existing Technology	Existing Technology	Existing Technology	Existing Technology		Existing Technology				Current Price Structure	from GTE	Current Price Structure	from GTE	Current Price	from GTE	Current Price Structure	from GTE		
Quantity (High)	te *												te *												
Quantity (Low)	Introductory State *												Introductory State												
Unit Price (High)	troduct	110	22				10	7	_	_		2	troduc	0.5	0.5	1.2		8.4		8.4		72			
Unit Price (Low)	드	06	18				2	0.5	0.5	0.5		3	믹	0.4	0.2	9.0		4.8		4.8		24			
Years to Replacement (Life Cycle)		20	20				10	20	20	20		20													
Equipment Description		Integration	Software and Local DB Add-on	Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Workstation	Communication Line to RTS4 & EM Through DS0 Type Line	Communication Line to PS through DS1 Type Line	Communication Line to other TRM's through DS1 Type Line	Communication Line to Intermodal Transportion Service Provider	through DS3 Type Line		Maintenance for Processor @ 2% of Capital Cost	Maintenance for Workstation @ 5% of Capital Cost	RTS & EM Wireline Communications DS0 from Data Loading	(see Common Equipment in Section 5.6)	PS Wireline Communication DS1 from Data Loading	(see Common Equipment in Section 5.6)	TRM Wireline Communication DS1 from Data Loading	(see Common Equipment in Section 5.6)	Wireline Communication DS3 from Data Loading	(see Common Equipment in Section 5.6)	Intermodal Transportation Service Provider	
		<u>=</u>		_		rrin nve	al le	stic	Cal	lai	_	)		<u>  &lt;                                   </u>		มรม	aui	вM		suo	_	-	_	<u>=  </u>	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.17-4 TRANSIT CENTER MULTI-MODAL COORDINATION, (TRM4)

### Transit Center Paratransit Operations (TRM5)

Equipment Description	Years to Replacement (Life Cycle)	Unit Price (Low)	Unit Price (High)	Quantity (Low)	Quantity (High)	Comparative Technology	Retail Price *	Unit Price	Quantity
		II	Introductory State *	ry Stat	*			Steady State *	tate *
Integration	20	100	200			Per Loral, Rockwell	well	100	
Processor/Software Upgrade, Installation and 1 yr. Maintenance	20	40	09			Experience in similar	milar	40	
						Integration Projects	ects		
Note: Software is off-the-shelf technology and unit price does									
not reflect product development.									
Communication included in TRM7									
		<u>n</u>	Introductory State	ry Stat	*			Steady State	tate *
Maintenance for Processor @ 2% of Capital Cost		0.8	1.2					0.8	

FIGURE 4.6.17-5 TRANSIT CENTER PARATRANSIT OPERATIONS, (TRM5)

### Transit Center Security (TRM6)

Quantity	State *									Steady State *									
Unit Price	Steady State	15	250	40		15			0.5	Steady	202			0.8	8.0	0.3		9.0	
Retail Price *		ology	well	imilar	ects	nology		ce										Structure	
Comparative Technology		Existing Technology	Per Loral, Rockwell	Experience in similar	Integration Projects	Existing Technology	Workstation for	Operator Interface										Current Price Structure	from GTE
Quantity (High)	ite *									ite *									
Quantity (Low)	Introductory State *									Introductory State *									
Unit Price (High)	ıtroduc	20	200	09		30			-	troduc	247			~	1.2	9.0		1.2	
Unit Price (Low)	u I	15	250	40		15			0.5	ᆸ	202			0.8	0.8	0.3		9.0	
Years to Replacement (Life Cycle)		10	20	10		10			20	-									
Equipment Description		Video Monitors (5 per site)	Integration	•,		Workstations (3)			Communication Line DS0 to Remote CATV's		Additional Staff (3) @ \$75,000 each average	Note : Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	Maintenance for Video Monitors @ 5% of Capital Cost	Maintenance for Server @ 2% of Capital Cost	Maintenance for Workstations @ 2% of Capital Cost		Remote CATV Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)
			(ţuə	шţs		Recu			tinl)		(	əsue		rring Naii		Re Rions	bera	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.17-6 TRANSIT CENTER SECURITY, (TRM6)

### Transit Center Tracking and Dispatch (TRM7)

Quantity	State *													State *													
Unit Price	Steady State	10	0.5	0.5	9	40	20	40	215	200	15			Steady State	9	9	202			4.8		9.0		24		24	
Retail Price *		ology				well	similar	ojects			ology									tructure							
Comparative Technology		Existing Technology				Per Loral, Rockwell	Experience in similar	Integration Projects			Existing Technology									Current Price Structure	from GTE						
Quantity (High)	ite *													ate *													
Quantity (Low)	Introductory State *													Introductory State													
Unit Price (High)	ntroduc	15	0.1	_	19	100	40	80	200	1000	30			ntroduc	6	1.2	247			8.4		1.2		72		72	
Prior (Low	Ir	10	0.5	0.5	9	40	20	40	215	200	15			1	9	9	202			4.8		9.0		24		24	
Years to Replacement (Life Cycle)		20	20	20	20	20	20	20	20	20	10																
Equipment Description		Vehicle Location Interface	, TMS Communication line; DS1 Type	PIAS & Others Communication Line; DS0 Type	Communication Line DS3 (2) 1 Line to ISP & 1 Line to RTS	Vehicle Tracking & Scheduling	Database and Information Storage	Schedule Adjustment Software	Real Time Travel Information Software	Integration	Workstations (3)	Note : Software is off-the-shelf technology and unit price does	not reflect product development.		Building Space (Add'l. req'd. for ITS tech \$12-18 / S.F., 500 S.F.)	Database Management Contract @ 10% of DB Scheduling	Additional Staff (3) @ \$75,000 each	Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	TMS Wireline Communication DS1 from Data	Loading (see Common Equipment in Section 5.6)	PIAS & Others Wireline Communication DS0 from Data	Loading (see Common Equipment in Section 5.6)	ISP Wireline Communication DS3 from Data	Loading (see Common Equipment in Section 5.6)	RTS Wireline Communication DS3 from Data	Loading (see Common Equipment in Section 5.6)
-			•		mjs	εeλ	սլլ	etic		lai	)iul				<u> </u>		our			sМ		suo					

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.17-7 TRANSIT CENTER TRACKING AND DISPATCH, (TRM7)

### 4.6.18. Transit Vehicle Subsystem (TRVS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
On-board Maintenance	TRV1
On-board Transit Driver I/F	TRV2
On-board Transit Fare and Load Management	TRV3
On-board Transit Security	TRV4
On-board Trip Monitoring	TRV7
On-board Vehicle Signal Coordination	TRV5
Vehicle Dispatch Support	TRV6

In determining the communication expenses for these Equipment Packages, the following assumptions were used. The wireless data loading communication usage for TRV2, TRV3, and TRV7, are based on the following additional assumptions.

- 1 (Transit services for vehicle fares) is performed at the end of the day in the yard via U2 interface not by CDPD. This removes the data flow from the CDPD cost equation, and is key to reducing the unit price per vehicle. Other data flows for this Equipment Package utilize CDPD communications.
- 2. The dataflow from TRVS to TRMS for loading etc., is sent every two minutes.

These changes have been made from the data loading analysis to create more realistic data rates. The resulting utilization for these Equipment Packages are: TRV2 required usage 820 Kbytes per month; TRV3 required usage 2,360 Kbytes per month; TRV7 required usage 3,180 Kbytes per month

Typical equipment for each Equipment Package is described below.

### 4.6.18.1 On-board Maintenance, (TRV1)

This Equipment Package provides the capability to use transit vehicle mileage data to automatically generate preventative maintenance schedules for each specific bus by utilizing vehicle tracking data and storing with a trip computer. It also provides the capability for real-time condition monitoring on board the vehicle, and transmission of this information via two-way communication to the management center. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.18.2 On-board Transit Driver I/F, (TRV2)

This Equipment Package provides the capabilities for automated planning and scheduling, by collecting data for schedule generation. Capability is also provided to automatically determine optimum scenarios for schedule adjustment. The Equipment Package also

furnishes transit travelers with real-time travel related information, continuously updated with real-time information from each transit system within the local area of jurisdiction, inclusive of all transportation modes, from all providers of transportation services, and provide users with the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents conditions, weather conditions, and special events. This package also supports the capability for two-way voice communication between the transit vehicle driver and a facility, two-way data communication between the transit vehicles and a facility, on-board safety sensor data to be transmitted from the transit vehicles to a facility, and data transmission from individual facilities to a central facility for processing/analysis if desired. These communication capabilities are provided through cell based radio system. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above. Vehicle location is provided through TRV7.

### 4.6.18.3 On-board Transit Fare and Load Management, (TRV3)

This Equipment Package provides the capability to collect data required to determine accurate ridership levels and implement variable and flexible fare structures. Support is provided for the traveler for use of a fare medium for all applicable surface transportation services, to pay without stopping, have payment media automatically identified as void and/or invalid and eligibility verified, and allow for third party payment. In addition, capability to provide expansion into other uses for payment medium such as retail and telephone and for off-line billing for fares paid by agencies is supported. This Equipment Package also supports the capability for two-way voice communication between the transit vehicle driver and a facility, two-way data communication between the transit vehicles and a facility, sensor data to be transmitted from the transit vehicles to a facility, and data transmission from individual facilities to a central facility for processing/analysis if desired. These capabilities require integration with the TRV2 Equipment Package cell based radio for communication. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.18.4 On-board Transit Security, (TRV4)

This Equipment Package provides the capability to monitor the safety of transit vehicles using on-board video images, as well as other safety sensors, processors and communications from the prerequisite On-board Transit Driver Interface Equipment Package (TRV2). Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.18.5 On-board Trip Monitoring, (TRV7)

This Equipment Package provides the Transit Vehicle Subsystem the capabilities to support fleet management with automatic vehicle location and automated mileage and fuel reporting and auditing. This includes only the equipment on board the vehicle to support this function including the vehicle location devices such as GPS equipment, communication interfaces, a

processor to record trip length, and the sensors/actuators/interfaces necessary to record mileage and fuel usage. The prerequisite equipment in TRV2 is required for communications. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.18.6 On-board Vehicle Signal Coordination, (TRV5)

This Equipment Package provides the capability for vehicles to request signal priority or preemption, through communication either to the roadside or to the traffic management center. This equipment is independent of other packages. However, the package deployment must be coordinated with the TMS and RS subsystems Equipment Packages for signal control.

### 4.6.18.7 Vehicle Dispatch Support, (TRV6)

This Equipment Package forwards dispatch requests to the driver and forwards acknowledgements to the center. This Equipment Package also supports display and operator coordination for demand response transactions. This package relies on the existence of the equipment in TRV2. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### On-board Maintenance (TRV1)

Quantity	State *									State *									
Unit Price	Steady State *	l	0.25	7	5					Steady State	9.0		0.01	0.01	90.0				
Retail Price *		logy	logy	100 88							ructure								
Comparative Technology		Existing Technology	Existing Technology	Comparable to 286 CDL							Current Price Structure	from GTE							
Quantity (High)	te *									te *									
Quantity (Low)	Introductory State *									Introductory State									
Unit Price (High)	troduct	2	0.5	7,7	5					troduct	0.7		0.02	0.01	0.1				
Unit Price (Low)	ľ	1	0.25	7	5					Ē	9.0		0.01	0.01	0.05				
Years to Replacement (Life Cycle)		10	10	5	2														
Equipment Description		Transit Vehicle Communications Interface	Mileage & End Reporting Sensors	On-board Processor for Trip Reporting and Data Storage				Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Wireless Communication Med from Data	Loading (see Common Equipment in Section 5.6)	Maintenance for Sensors @ 2% of Capital Cost	Maintenance for Processor @ 2% of Capital Cost	Maintenance for Communications Interface @ 5% of Capital Cost				
				ıəw:	sən	ral Ir			)		<u>  &gt; </u>		_	ļui	eM s	Reci	)ber	<b>O)</b>	

\* All prices are in thousands of 1995 dollars.

### On-board Transit Driver I/F (TRV2)

Pescription   Peplacement   Price   Intro	Quantity	State *											State *									
Percription	Unit Price	Steady (	0.15		0.3		4		0.1				Steady (	0.18	9.0		0.01	0.01	0.2	0.01		
Description   Replacement Price   Pr	Retail Price *		logy Price	0	chnology	atabase	ology in	ies	ology					tructure								
Description   Price    Comparative Technology		Current Techno	Range 0.1 to 1.	Comparable Te	286 CPU w/ Da	Existing Techno	Transit Facilit	Existing Techno	"Panic Button"				Current Price S	from GTE								
Description   Prior   Unit (Life Cycle)   (Low (Life Cycle)   (Life Cycle)   (Life Cycle)   (Life Cycle)   (Life Cycle)   (Low (Life Cycle)   (L	Quantity (High)	te *											te *									
Description   Prior   Unit (Life Cycle)   (Low (Life Cycle)   (Life Cycle)   (Life Cycle)   (Life Cycle)   (Life Cycle)   (Low (Life Cycle)   (L	Quantity (Low)	ory Sta											ory Sta									
Description   Prior   Unit (Life Cycle)   (Low (Life Cycle)   (Life Cycle)   (Life Cycle)   (Life Cycle)   (Life Cycle)   (Low (Life Cycle)   (L	Unit Price (High)	troduct	0.25		0.5		2		0.15				troduct	0.2	9.0		0.01	0.01	0.25	0.01		
bB  Schedule & DB Interface  e Schedule & DB Interface  ar  Operated  Annology and unit price does  ment.  y to Facility Wireless  Jse  of Capital Cost of Capital Cost  Sapital Cost  2% of Capital Cost  2% of Capital Cost	Unit Price (Low)	<u>u</u>	0.15		0.3		4		0.1				In	0.18	9.0		0.01	0.01	0.2	0.01		
Description  y  y  SB  e Schedule & DB  ar  Operated  Operated  A to Facility Wirelt  Jse  of Capital Cost of Capital Cost  apital Cost  Z% of Capital Cost  2% of Capital Cost	Years to Replacement (Life Cycle)		10		10		10		2				_									
	Equipment Description		Cell Based Radio w/ Data Capacity				On-board TV Monitor w/ Real Time Schedule & DB Interface	for fare, routes, incidents, weather	On-board Safety Sensor Manually Operated		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Driver to Facility & Vehicle Display to Facility Wireless	CDPD Communications Medium Use		Maintenance for Cell Radio @ 5% of Capital Cost		Maintenance for CATV @ 5% of Capital Cost	ပိ		

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.18-2 ON-BOARD TRANSIT DRIVER I/F, (TRV2)

# On-board Transit Fare and Load Management (TRV3)

Quantity	State *									State *										
Unit Price	Steady State *	6.4	0.3	0.5						Steady State	0.18	1.2		0.01	0.01	0.01				
Retail Price *		logy	chnology		dia Nat'l Labs						ructure									
Comparative Technology		Existing Technology	Comparable Technology	286 CPU w/ DB	Ref. FTA & Sandia Nat'l Labs						Current Price Structure	from GTE								
Quantity (High)	te *									te *										
Quantity (Low)	Introductory State *									Introductory State										
Unit Price (High)	troduc	9.0	0.5	-						troduc	0.2	4.1		0.01	0.01	0.05				
Unit Price (Low)	드	0.4	0.3	0.5						드	0.18	1.2		0.01	0.01	0.01				
Years to Replacement (Life Cycle)		10	10	10						-										
Equipment Description		On-board Ridership Sensor System	On-board Flex Fare System DBX Processor	On-board Farebox & Smart Card Reader				Note : Software is off-the-shelf technology and unit price does			Driver to Facility & Vehicle Display to Facility Wireless	CDPD Communications High		Maintenance for Sensors @ 2% of Capital Cost	Maintenance for Processor @ 2% of Capital Cost	Maintenance for Farebox @ 5% of Capital Cost				
		<u>U</u>					Non-I I Cap						oueu	əjui	вM		rati	əd(	<b>)</b>	

\* All prices are in thousands of 1995 dollars.

### On-board Transit Security (TRV4)

Quantity	Steady State *								Steady State *								
Unit Price	Stead	0.1		4					Stead	0.18		0.01	0.2				
Retail Price *		chnology		logy						tructure							
Comparative Technology		Comparable Technology	286 CPU w/ DB	Existing Technology						Current Price Structure	from GTE						
Quantity (High)	te *								te *								
Quantity (Low)	Introductory State *								Introductory State								
Unit Price (High)	troduct	0.15		2					troduct	0.2		0.01	0.25				
Unit Price (Low)	lu	0.1		4					ln	0.18		0.01	0.2				
Years to Replacement (Life Cycle)		10		10													
Equipment Description		On-board Safety Sensor Processor		On-board CCTV			Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Wireless Communication Low for Video Processing from Data	Loading (see Common Equipment in Section 5.6)	Maintenance for Processor @ 2% of Capital Cost	Maintenance for CCTV @ 5% of Capital Cost				
		<u>)</u>	()	_	urring Investm					>		snətni	eM ,	Reci	perat	0)	

### On-board Trip Monitoring (TRV7)

Quantity	State *											State *										
Unit Price	Steady State	0.1	1	0.25		0.5						Steady State	1.308		0.01	0.01	0.01					
Retail Price *		logy	-	chnology		ructure	orld)						ructure									
Comparative Technology		Existing Technology	:	Comparable Technology	286 CPU w/ DB	Current Price Structure	(Ref. GPS World)						Current Price Structure	from GTE								
Quantity (High)	te *											te *										
Quantity (Low)	Introductory State *											Introductory State *										
Unit Price (High)	troduct	0.15	ı	0.5		0.8						troduct	1.499		0.01	0.02	0.02					
Unit Price (Low)	2	0.1	(	0.25		0.5						Ľ	1.308		0.01	0.01	0.01					
Years to Replacement (Life Cycle)		10		10		10																
Equipment Description		Processor/Trip Computer		Automated Mileage & Fuel Reporting Sensors Communications	Interface through TRV2	4			-	Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Wireless Communications High Plus Excess Use		Maintenance for Trip Computer @ 2% of Capital Cost	Maintenance for Censors @ 5% of Capital Cost	Maintenance for GPS/DGPS					
		l Œ			njs	εeν		Nor I Ca	tia		)		>	(əɔı		ļui	вM	Recn ช suc	oite	ber	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.18-5 ON-BOARD TRIP MONITORING, (TRV7)

### On-board Vehicle Signal Coordination (TRV5)

	Unit Price Quantity	Steady State *	0.3		0.15		0.5					Steady State *	0.01	0.01	0.01						_
	Retail Price * Un	S					Je					S		_							
			Comparable Technology	w/ DB	Current Technology Voice	1 to 1.0)	Current Price Structure	(Ref. GPS World)													_
	Comparative		Comparab	286 CPU w/ DB	Current Te	Radios (0.1 to 1.0)	Current Pr	(Ref. GP													_
	ity Quantity (High)	tate *										tate *									
•	t Quantity e (Low)	Introductory State *	10		2		3					Introductory State *	1	1	2						
	it Unit ce Price w) (High)	Introdu	3 0.5		5 0.25		5 0.8					Introdu	10.01	10.01	0.02						_
	Duit ent Price (Low)		0.3		0.15		0.5						0.01	0.01	0.01						
)	Years to Replacement (Life Cycle)		10		10		10					·									
	Equipment Description		On-board Processor & DB		Cell Based Radio System & Data Transceiver Capability		GPS/DGPS			Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Maintenance for Cell Radio @ 2% of Capital Cost	Maintenance for Processor @ 2% of Capital Cost	Maintenance for GPS/DGPS @ 2% of Capital Cost						
				()			ЭΛ		aA-n stiqe								nuo 8 R	its.	ıəd	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.18-6 ON-BOARD TRIP MONITORING, (TRV5)

### Vehicle Dispatch Support (TRV6)

Quantity	State *								State *								
Unit Price	Steady State *								Steady State *	0.18							
Retail Price *										ructure							
Comparative Technology										Current Price Structure	from GTE						
Quantity (High)	te *								te *								
Quantity (Low)	Introductory State *								Introductory State *								
Unit Price (High)	troduct								troduct	0.2							
Unit Price (Low)	ul								므	0.18							
Years to Replacement (Life Cycle)																	
Equipment Description		No New Equipment	Relies on TRV2							Wireless Communication Low from Data	Loading (see Common Equipment in Section 5.6)						
		<u>                                     </u>		uəu		Pec Istic		iul)		<u> </u>	(əsu	euə:	curri 8. M	ite.	ıəd(	<b>)</b>	

\* All prices are in thousands of 1995 dollars.

### 4.6.19. Personal Vehicle Subsystem (VS)

This subsystem contains the following Equipment Packages:

<b>Equipment Package Name</b>	Descriptor
Basic Vehicle Reception	VS1
Driver Safety Monitoring System	VS2
Driver Visibility Improvement System	VS3
In-Vehicle Signing System	VS4
Interactive Vehicle Reception	VS5
Probe Vehicle Software	VS6
Smart Probe	VS7
Vehicle Intersection Collision Warning	VS8
Vehicle Intersection Control	VS9
Vehicle Lateral Control	VS10
Vehicle Lateral Warning System	VS11
Vehicle Longitudinal Control	VS12
Vehicle Longitudinal Warning System	VS13
Vehicle Mayday I/F	VS14
Vehicle Pre-Crash Safety Systems	VS15
Vehicle Route Guidance	VS16
Vehicle Safety Monitoring System	VS17
Vehicle Systems for AHS	VS18
Vehicle Toll/Parking I/F	VS19

Each Equipment Package is described below.

### 4.6.19.1 Basic Vehicle Reception, (VS1)

This Equipment Package provides the capability for drivers to interface with the ISP Subsystem's Basic Information Broadcast Equipment Package and receive formatted traffic advisories including accurate traveling information concerning available travel options and their availability, and congestion information in their vehicle. These capabilities are based upon the reception of infrastructure information using in-vehicle devices such as an invehicle AM/FM radio with data subcarrier connected with the existing audio system and a dash-mounted LCD. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.19.2 Driver Safety Monitoring System, (VS2)

This Equipment Package provides the capability to determine the driver's condition and warn the driver of potential dangers. This package includes driver sensors to assess the suitability of the driver (e.g., fitness and alertness) to assume manual control of the vehicle.

### 4.6.19.3 Driver Visibility Improvement System, (VS3)

The Equipment Package provides the capability to augment the vehicle operator's ability to see objects in the vehicle path in conditions where driving visibility is poor (e.g., bad weather, night driving, etc.). These capabilities are provided using equipment such as on-board sensor system (e.g., an infrared sensor system) to create images that in turn could be relayed to the driver using a heads-up display. The on-board systems to implement this package include a local sensor system, an image creation and processing capability, and a visual display to the driver.

### 4.6.19.4 In-Vehicle Signing System, (VS4)

This Equipment Package provides the capability to assist individuals with impaired vision, individuals needing local guidance in areas that the driver is unfamiliar, and implemented in a manner that augments existing signs. This package also provides the capability to customize warnings, utilize data from roadside environmental sensors, and provide travelers with information on road conditions and with precautionary reminder messages. These capabilities are provided through the use of equipment such as an interface to active tag reader and processor to display the information from the active tag. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### **4.6.19.5** Interactive Vehicle Reception, (VS5)

This Equipment Package provides the capability for drivers to interface with the ISP Subsystem's Infrastructure Equipment Packages including the Interactive Infrastructure Information Equipment Package, the Infrastructure Provided Route Selection, Yellow Pages and Reservation, and Dynamic Ridesharing Equipment Packages. A prerequisite Equipment Package for this service is VS16. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.19.6 Probe Vehicle Software, (VS6)

This Equipment Package includes capabilities for the probe vehicle to identify its location, measure traffic conditions such as link travel time and speed and possibly environmental hazards such as icy road conditions, and transmit these data to either the ISP or TMC. A prerequisite Equipment Package for this service is VS16. Wireless communications are provided in VS16, Vehicle Route Guidance.

### **4.6.19.7 Smart Probe, (VS7)**

This Equipment Package provides for Vehicle Probes with added capability and intelligence to sense and send road conditions as the vehicle travels. Road conditions may include weather and roadway surface conditions, potholes, rough road in addition to speeds.

Communication functionality may be provided as part of VS16, Vehicle Route Guidance or independently with a vehicle tag.

### 4.6.19.8 Vehicle Intersection Collision Warning, (VS8)

This Equipment Package provides the capability for the detection of an impending collision with a moving or stationary object prior to crash impact in an intersection with notification provided to the driver of the presence of potentially hazardous situations and need for immediate collision avoidance action. These capabilities are provided through the use of equipment such as an intersection hazard warning sensor and actuator.

### 4.6.19.9 Vehicle Intersection Control, (VS9)

This Equipment Package provides the capability for the detection of an impending collision with a moving or stationary object prior to crash impact in an intersection and automatically avoid the intersection collision. These capabilities are provided through the use of equipment such as an intersection hazard warning sensor and actuator.

### **4.6.19.10** Vehicle Lateral Control, (VS10)

This Equipment Package provides the capability for lateral control of a vehicle on roads to allow "hands off" driving, automating the steering control function. This capability is provided through the use of equipment provided to detect lanes, obstacles or vehicles to the sides of the vehicle. This sensor information is processed on board the vehicle, and appropriate steering control actions are initiated using steering actuators. Appropriate lane maintenance may thus be maintained automatically.

### 4.6.19.11 Vehicle Lateral Warning System, (VS11)

This Equipment Package allows for lateral warning. It utilizes safety sensors and collision sensors . It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.

### 4.6.19.12 Vehicle Longitudinal Control, (VS12)

This Equipment Package provides the capability for longitudinal control of a vehicle on roads to allow "feet off" driving, automating the function of speed control, acceleration, and braking. This capability is provided through the use of equipment to detect obstacles or vehicles in the longitudinal path of the vehicle. This sensor information is processed on board the vehicle, and appropriate control actions (acceleration, braking, or maintaining speed) are initiated using accelerator and/or brake actuators. Appropriate following distances may thus be maintained automatically.

### 4.6.19.13 Vehicle Longitudinal Warning System, (VS13)

This Equipment Package allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.

### 4.6.19.14 Vehicle Mayday I/F, (VS14)

This Equipment Package provides the capability for an in-vehicle manually initiated distress signal with capability to cancel a prior issued manual request for help. This capability includes automatically identifying that a collision had occurred using equipment such as collision detection sensors with interface to MAYDAY type equipment that would automatically detect vehicle problems and for some cases, automatically send appropriate distress signals to the Emergency Management Subsystem. This equipment is similar in nature to that of PIAS Personal Mayday I/F Equipment Package. The vehicle location information for this package is provided through the prerequisite Equipment Package VS16. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### 4.6.19.15 Vehicle Pre-Crash Safety Systems, (VS15)

This Equipment Package provides the capability to sense local conditions, determine collision probability, and deploy a pre-crash safety system. These capabilities are provided by equipment such as on-board sensors to determine the location or distance away and closing rates of neighboring vehicles or other roadway obstacles. These detection systems are supplemented by additional sensors for existing weather and roadway conditions and roadway geometry. A processor in the vehicle assimilates this information and determine the probability of a collision with the other vehicle or obstacle. If the collision probability is high, it deploys a pre-crash safety system either to avoid the accident or to reduce the accident severity.

### 4.6.19.16 Vehicle Route Guidance, (VS16)

This Equipment Package provides the capability of Route Guidance. Thus, this package provides the capability to receive travel information from the infrastructure, but perform the route planning process in the vehicle. These capabilities are provided using equipment such as a processor with GIS software and GUI using communication medium and equipment such as mobile satellite telephone or cellular telephone. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### **4.6.19.17** Vehicle Safety Monitoring System, (VS17)

This Equipment Package provides the capability to diagnose critical components of the vehicle and warn the driver of potential dangers. These capabilities use equipment such as a

set of on-board sensors to monitor continuously the vehicle condition and performance, including steering, braking, acceleration, emissions, fuel economy, engine performance, etc. Problems with any of these systems are identified using processors on board the vehicle, providing a timely display to the driver of the situation. The sensors provide warnings to the driver in the event of a serious condition (e.g., likely failure or damage). A prerequisite Equipment Package for this service is VS16 for the GUI capability.

### 4.6.19.18 Vehicle Systems for AHS, (VS18)

This Equipment Package provides the capability for "hands-off" and "feet off" operations of an equipped vehicle on the automated portion of the highway system including the longitudinal control, lateral control for lane change/merge and roadway departure, regulating the vehicle speed and steering control, and sensing impending hazards and responding appropriately. These capabilities are provided by systems on board the vehicle to regulate longitudinal and lateral control maneuvers, including acceleration, braking, and steering functions. The capability to control access to the automated highway system is provided through an automated check-in procedure in which the vehicle and driver are checked for their fitness.

### 4.6.19.19 Vehicle Toll/Parking I/F, (VS19)

This Equipment Package provides the capability for vehicle operators to pay toll without stopping their vehicles and pay for parking without the use of cash. These capabilities are provided through the use of equipment such as an active tag interface and debit/credit card interface. Wireless communications are provided in accordance with the data loading analysis, as described in the common equipment section 4.6, above.

### Basic Vehicle Reception (VS1)

Quantity	State *				State *
Unit Price	Steady State *	0.15		0.05	Steady State *
Retail Price *		ЭУ	ЭУ	ЭУ	
Comparative Technology		Exist. Technology	Exist. Technology	Exist. Technology	
Quantity (High)	*	1x10 <sup>6</sup>		1x10 <sup>6</sup>	* •
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>		1x10 <sup>5</sup>	Introductory State *
Unit Price (High)	roduct	0.18	0	0.1	o o contraction o o contractio
Unit Price (Low)	ī	0.15	0	0.05	0
Years to Replacement (Life Cycle)		7		7	
Equipment Description		In Vehicle AM/FM Radio w/data subcarrier connection	Existing Audio System	Dash Mounted LCD	Wireless Communication Low from Broadcast
				_	Recutring Mon-Recutring (Initial Capital Investm

\* All prices are in thousands of 1995 dollars.

### Driver Safety Monitoring System (VS2)

		Safety		ema	səxu	-Rec Dital	sitinl	)		Mainte		eusı		ซู รเ าวอ <sub>ิ</sub> ง	ber	0)	
Equipment Description		Safety Collection Processor and Software	Driver Condition Sensors	Note: Software is off-the-shelf technology and unit price does	not reflect product development.					Maintenance for Processor @ 2% of Capital Cost	Maintenance for Sensors @ 5% of Capital Cost						
Years to Replacement (Life Cycle)		7	7														
Unit Price (Low)	Int	60.03	0.4						Int	0.01	0.02						
Unit Price (High)	roduct	0.05	0.8						roduct	0.01	0.04						
Quantity (Low)	Introductory State *	$1x10^{5}$	1x10 <sup>5</sup>						Introductory State *								
Quantity (High)	*	$1x10^6$							*								
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.														
Retail Price *		omotive Est.	omotive Est.														
Unit Price	Steady State	0.03	0.4						Steady State	0.01	0.02						
Quantity	state *								state *								

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.19-1 DRIVER SAFETY MONITORING SYSTEM, (VS2)

### Driver Visibility Improvement System (VS3)

Quantity	State *											State *									
Unit Price	Steady State *	0.4	0.1	0.5	0.2							Steady State	0.01	0.01	0.03	0.01					
Retail Price *		well		ects	chnology	nancement															
Comparative Technology		Per Loral, Rockwell	Exper. in similar	Integration Projects	Comparative Technology	Night Vision Enhancement															
Quantity (High)	*	1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>								te *									
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>								Introductory State									
Unit Price (High)	troduct	9.0	0.2	-	0.4							troduct	0.01	0.01	0.05	0.02					
Unit Price (Low)	ב	0.4	0.1	0.5	0.2							<u>lı</u>	0.01	0.01	0.03	0.01					
Years to Replacement (Life Cycle)		7	7	7	7																
Equipment Description		In-Vehicle Camera	Software and Processor	Heads-Up Display	Infra-red Sensors (Local sensor system)		Note: Software is off-the-shelf technology and unit price does	not reflect product development.					Maintenance for Processor @ 2% of Capital Cost	Maintenance for Display @ 5% of Capital Cost	Maintenance for Sensors @ 5% of Capital Cost	Maintenance for Camera @ 5% of Capital Cost					
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\* All prices are in thousands of 1995 dollars.

### In-Vehicle Signing System (VS4)

Quantity	State *											State *								
Unit Price	Steady State *	0.05	0.05	90.0								Steady State			0.01					
Retail Price *		well exper. in	on Projects,	tomotive Est.																
Comparative Technology		Per Loral, Rockwell exper. in	Similar Integration Projects,	and Seimens Automotive Est.																
Quantity (High)	*	1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>								te *								
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>								Introductory State								
Unit Price (High)	troduct	0.1	0.1	0.2								troduct	0		0.01					
Unit Price (Low)	Ē	0.05	0.05	90.0								In	0		0.01					
Years to Replacement (Life Cycle)		7	7	7																
Equipment Description		Interface to Active Tag Reader	Processor for Active Tag Decode	Display device for messages		Note: Software is off-the-shelf technology and unit price does	not reflect product development.						Wireless Communication Low from Short Range System		Maintenance for Equipment @ 2% of Capital Cost					
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\* All prices are in thousands of 1995 dollars.

### Interactive Vehicle Reception (VS5)

Quantity	State *								State *								
Unit Price	Steady State *		0.1						Steady State *	90.0							
Retail Price *			utomotive Est.														
Comparative Technology			Ref. Seimens Automotive Est.														
Quantity (High)	te *	ď	1x10°						te *								
Quantity (Low)	Introductory State *	4	1x10 <sup>3</sup>						Introductory State *								
Unit Price (High)	troduct	-	0.15						troduct	0.12							
Uni Pric	In	,	0.1						'n	90.0							
Years to Replacement (Life Cycle)			_														
Equipment Description			Software and Processor Upgrade	Note : Software is off-the-shelf technology and unit price does						Monthly ISP Service Fee (\$5-\$10/per month)							
				əmis	eλu	-Recu Dital I	1 Isitin	II)			(əɔu	euəj	curr & N	rati	əd(	<b>)</b>	

\* All prices are in thousands of 1995 dollars.

### Probe Vehicle Software (VS6)

Quantity	State *									State *									
Unit Price	Steady State *	90'0								Steady State			0.01						
Retail Price *		utomotive Est.									ructure								
Comparative Technology		Ref. Seimens Automotive Est.									Current Price Structure	from GTE							
Quantity (High)	te *	1x10 <sup>6</sup>								te *									
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>								Introductory State									
Unit Price (High)	troduct	0.15								troduct		0	0.01						
Unit Price (Low)	Ξ	0.05								Inf		0	0.01						
Years to Replacement (Life Cycle)		7																	
Equipment Description		Software and Processor for communication to roadside	infrastructure, Signal Generator, Message Generator	Note: Software is off-the-shelf technology and unit price does	not reflect product development.						Wireless Communication Included in VS16	(see Common Equipment in Section 5.6)	Maintenance for Equipment @ 2% of Capital Cost	-					
-		S	(JL	uļs		Recu Ital I		iul)			>		_	lainte	curr 8.8.N	iter	əd(	<b>D)</b>	

\* All prices are in thousands of 1995 dollars.

### Smart Probe (VS7)

Quantity	state *												state *								
Unit Price	Steady State	0.2	0.05	0.02	0.05	0.05	0.1	0.02	0.05				Steady State		0.0088						
Retail Price *		utomotive Est.	utomotive Est.	logy	logy	logy	Automotive Es	logy	) de												
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.	Existing Technology	Existing Technology	Existing Technology	Ref. Seimens Automotive	Exist. Technology	Exist. Technology												
Quantity (High)	te *							1x10 <sup>6</sup>	1x10 <sup>6</sup>				*								
Quantity (Low)	Introductory State *							1x10 <sup>5</sup>	1x10 <sup>5</sup>				Introductory State								
Unit Price (High)	troduct	0.3	0.1	0.05	0.1	0.1	0.2	0.05	0.1				troduct	0	0.016						
Unit Price (Low)	ul	0.2	0.05	0.02	0.05	0.05	0.1	0.02	0.05				'n	0	0.009						
Years to Replacement (Life Cycle)		7	7	7	7	7	7	7	7												
Equipment Description		Roadway Surface Sensors (roughness)	Roadway (temperature)	Air (temperature)	Air (relative humidity)	Air (relative wind - pilot tube)	Software and Processor for transmission of data	Active Tag	Tag Processor for Active Tag Decode	Note: Software is off-the-shelf technology and unit price does		not reflect product development.		No Wireless Communication Cost from Data Loading	Maintenance for Equipment @ 2% of Capital Cost						
					mjs	εeλ	uj ji	stic	Mon I Cal		-				esuce)	gnir Nain		iter	ıəd(	0)	

\* All prices are in thousands of 1995 dollars.

### Vehicle Intersection Collision Warning (VS8)

Quantity	State *									State *										
Unit Price	Steady State *	0.05	0.03							Steady State	0.01									
Retail Price *		utomotive Est.	utomotive Est.																	
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.																	
Quantity (High)	te *	1x10 <sup>6</sup>								te *										
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>							Introductory State										
Unit Price (High)	troduct	0.1	0.05							troduct	0.01									
Unit Price (Low)	ul	0.05	0.03							u	0.01									
Years to Replacement (Life Cycle)		7	7							-										
Equipment Description		Software / Processor for infrastructure transmitted information	Interface to In-Vehicle Signing and Audio System	Note: Software is off-the-shelf technology and unit price does	not reflect product development.						Maintenance for Equipment @ 2% of Capital Cost									
				÷Α			/ tial	iul)	)			(ə:	auc	uə	ırriı M.		ite:	iəd	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.19-8 VEHICLE INTERSECTION COLLISION WARNING, (VS8)

### Vehicle Intersection Control (VS9)

Quantity	State *										State *								
Unit Price	Steady State *	0.2									Steady State	0.01							
Retail Price *		utomotive Est.																	
Comparative Technology		Ref. Seimens Automotive Est.																	
Quantity (High)	ite *	1x10 <sup>6</sup>									ite *								
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>									Introductory State *								
Unit Price (High)	troduci	9.0									troduct	0.01							
Unit Price (Low)	In	0.2									ıu	0.01							
Years to Replacement (Life Cycle)		7																	
Equipment Description		Software and Processor to link to Longitudinal and Lateral	Vehicle Control Modules based on input signal from Vehicle	Intersection Collision Warning Equipment Package		Note: Software is off-the-shelf technology and unit price does	not reflect product development.					Maintenance for Equipment @ 2% of Capital Cost							
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\* All prices are in thousands of 1995 dollars.

### Vehicle Lateral Control (VS10)

Quantity	State *										State *								
Unit Price	Steady State *	0.5	0.5								Steady State	0.02							
Retail Price *		utomotive Est.	utomotive Est.																
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.																
Quantity (High)	*	1x10 <sup>6</sup>	1x10 <sup>6</sup>								te *								
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>								Introductory State *								
Unit Price (High)	roduct	9.0	9.0								roduct	0.02							
Unit Price (Low)	Ξ	0.5	0.5								In	0.02							
Years to Replacement (Life Cycle)		7	7																
Equipment Description		Advanced Steering Control	Lane Sensors in Vehicle (proximity lateral sensors in separate	Equipment Package)		Note: Software is off-the-shelf technology and unit price does	not reflect product development.					Maintenance for Equipment @ 2% of Capital Cost							
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\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.19-10 VEHICLE LATERAL CONTROL, (VS10)

## Vehicle Lateral Warning System (VS11)

Quantity	State *										State *									
Unit Price	Steady State *	0.3	0.05								Steady State	0.01								
Retail Price *		utomotive Est.	utomotive Est.																	
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.																	
Quantity (High)	*	1x10 <sup>6</sup>	1x10 <sup>6</sup>								te *									
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>								Introductory State *									
Unit Price (High)	troduct	0.5	0.1								troduct	0.01								
Unit Price (Low)	בֿ	0.3	0.05								ıu	0.01								
Years to Replacement (Life Cycle)		7	7																	
Equipment Description		Lateral Sensors MMW Radar	In-Vehicle Display / Warning Interface		Note: Software is off-the-shelf technology and unit price does	not reflect product development.						Maintenance for Equipment @ 2% of Capital Cost								
	Mon-Recurring (Initial Capital Investment)									_	(əɔ	บยเ		curr 8. N	oits.	ıəd	0)			

\* All prices are in thousands of 1995 dollars.

## Vehicle Longitudinal Control (VS12)

Quantity	State *								State *								
Unit Price	Steady State *		0.1	0.05					Steady State	0.01							
Retail Price *			utomotive Est.	utomotive Est.													
Comparative Technology			Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.													
Quantity (High)	te *		1x10 <sup>6</sup>	1x10 <sup>6</sup>					te *								
Quantity (Low)	Introductory State *		1x10 <sup>5</sup>	1x10 <sup>5</sup>					Introductory State *								
Unit Price (High)	troduct		0.2	0.1					troduct	0.01							
Unit Price (Low)	ㅁ		0.1	0.02					드	0.01							
Years to Replacement (Life Cycle)			7	7					-								
Equipment Description		Adaptive Cruise Control	Automatic Braking	Automatic Accelerating	Note - Software is off-the-shelf technology and unit price does	not reflect product development.				Maintenance for Equipment @ 2% of Capital Cost							
			(1	นอน	gui nisə		Mon S Ca	II)			(əɔu	euə	urri 8. M	its.	iəd(	0)	

\* All prices are in thousands of 1995 dollars.

# Vehicle Longitudinal Warning System (VS13)

Quantity	State *									State *								
Unit Price	Steady State *	0.3	0.05							Steady State	0.01							
Retail Price *		utomotive Est.	utomotive Est.															
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.															
Quantity (High)	*	1x10 <sup>6</sup>	1x10 <sup>6</sup>							*								
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>							Introductory State *								
Unit Price (High)	troduct	0.5	0.1							troduct	0.01							
Unit Price (Low)	Ξ	0.3	0.02							Ī	0.01							
Years to Replacement (Life Cycle)		7	7															
Equipment Description		Longitudinal Sensors MMW Radar	In-Vehicle Display / Warning Interface	Note: Software is off-the-shelf technology and unit price does	not reflect product development.						Maintenance for Equipment @ 2% of Capital Cost							
				ıəwı	SƏA	noes tal In		iul)	ı			(əɔu	eus	curri & M	ite.	iəd	0)	

\* All prices are in thousands of 1995 dollars.

### Vehicle Mayday I/F (VS14)

Quantity	State *											State *									
Unit Price	Steady State *	0.05	0.1	0.1								Steady State	0	0.12	0.01						
Retail Price *		logy	vir bag sensors	& Mayday panic button services																	
Comparative Technology		Existing Technology	comparable to Air bag sensors	& Mayday panic																	
Quantity (High)	*	1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>								* *									
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>								Introductory State									
Unit Price (High)	troduct	0.5	0.15	0.15								troduct	3	0.18	0.02						
Unit Price (Low)	드	0.05	0.1	0.1								띡	0	0.12	0.01						
Years to Replacement (Life Cycle)		7	7	7								_									
Equipment Description		Collision Detection Sensor	Interface for Mayday Processor	I/F for Wireless Communication		Note: Software is off-the-shelf technology and unit price does	not reflect product development.						(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	Monthly ISP Service Fee (10-\$15/per month)	Maintenance for Equipment @ 2% of Capital Cost	-					
	Mon-Recurring (Initial Capital Investment)												≥ ugu	) ju	nos	its.	ıəd	0)			

\* All prices are in thousands of 1995 dollars.

## Vehicle Pre-Crash Safety Systems (VS15)

Quantity	State *									State *								
Unit Price	Steady State *	0.1	0.4	0.1	0.4	0.1				Steady State	0.01	0.03						
Retail Price *		utomotive Est.	utomotive Est.	utomotive Est.	utomotive Est.	utomotive Est.												
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.															
Quantity (High)	:e *	1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>				*								
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>				Introductory State								
Unit Price (High)	troduct	0.2	9.0	0.15	-	0.2				troduct	0.03	0.04						
Unit Price (Low)	In	0.1	0.4	0.1	0.4	0.1				lu	0.01	0.03						
Years to Replacement (Life Cycle)		7	7	7	7	7												
Equipment Description		Vehicle Condition Sensors	Vehicle Performance Sensors	Software / Processor	Interface to other Equipment Packages	Pre-crash Safety Systems Deployment Actuators	Note : Software is off-the-shelf technology and unit price does	not reflect product development.			Maintenance for Equipment @ 2% of Capital Cost	Maintenance for Sensors @ 5% of Capital Cost						
		>	-		mjs	εə∧u	-Recu Dital II S	Cat	AI)		2	( <del>2</del> )	eus		s su	ber	0)	

\* All prices are in thousands of 1995 dollars.

FIGURE 4.6.19-15 VEHICLE PRE-CRASH SAFETY SYSTEMS, (VS15)

### Vehicle Route Guidance (VS16)

Quantity	state *											State *											
Unit Price	Steady State *	0.05	0.2	0.1	0.25	0.2						Steady State		0.18	0.12	0.01	0.01	0.01	0.01				
Retail Price *		vell		cts	3PS World)	tomotive Est.							ructure										
Comparative Technology		Per Loral, Rockwell	Exper. in similar	Integration Projects	Current Prices (GPS World)	Ref. Seimens Automotive Est.						-	Current Price Structure	from GTE									
Quantity (High)	*	1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>		1x10 <sup>6</sup>						*											
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>		1x10 <sup>5</sup>						Introductory State											
Unit Price (High)	troduct	0.1	0.3	0.15	0.5	0.4						roduct		0.2	0.18	0.02	0.01	0.01	0.01				
Unit Price (Low)	重	0.05	0.2	0.1	0.25	0.2						Int		0.18	0.12	0.01	0.01	0.01	0.01				
Years to Replacement (Life Cycle)		7	7	7	7	7						-											
Equipment Description		ln9	GIS Software	Limited Processor	GPS / DGPS	Wireless Data Transceiver	Note: Software is off-the-shelf technology and unit price does	not reflect product development.					Wireless Communication Low from Data Loading	(see Common Equipment in Section 5.6)	Monthly ISP Service Fee (10-\$15/per month)	Maintenance for GPS @ 2% of Capital Cost	Maintenance for GUI @ 5% of Capital Cost	Maintenance for Processor @ 2% of Capital Cost	Maintenance for Transceiver @ 2% of Capital Cost				
		<u>. U</u>	_	_	шţs	εeλί	ul le ince			inl	)		<u>&gt;</u>	_			<b>Jui</b>	вM	≥ ຮູຮ noə	rat	əd(	<b>O)</b>	_

\* All prices are in thousands of 1995 dollars.

## Vehicle Safety Monitoring System (VS17)

Quantity	State *											State *										
Unit Price	Steady State *	0.03	0.18	0.05								Steady State	0.01	0.01								
Retail Price *		well		ects																		
Comparative Technology		Per Loral, Rockwell	Exper. in similar	Integration Projects																		
Quantity (High)	*	1x10 <sup>6</sup>										* • •										
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>								Introductory State *										
Unit Price (High)	troduct	0.05	0.3	0.1								troduct	0.01	0.02								
Unit Price (Low)	ב	0.03	0.18	0.05								u	0.01	0.01								
Years to Replacement (Life Cycle)		7	7	7																		
Equipment Description		Safety Collection Processor	Vehicle Condition Sensors (6 at \$50 each)	Vehicle Data Storage		Note: Software is off-the-shelf technology and unit price does	not reflect product development.						Maintenance for Processor @ 2% of Capital Cost	Maintenance for Sensors @ 5% of Capital Cost								
		Mon-Recurring (Initial Capital Investment)										<u>                                     </u>		วนช	uə:	ırriı M		ijer	ıəd	0)		

\* All prices are in thousands of 1995 dollars.

### Vehicle Systems for AHS (VS18)

Quantity	state *												state *										
Unit Price	Steady State	0.2	0.2	0.2	0.05	0.2	0.2						Steady State	0.01	0.01	0.01							
Retail Price *		utomotive Est.	utomotive Est.	utomotive Est.	utomotive Est.	utomotive Est.	Automotive Es																
Comparative Technology		Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.	Ref. Seimens Automotive Est.	Ref. Seimens Automotive																
Quantity (High)	te *	1x10 <sup>6</sup>			1x10 <sup>6</sup>	1x10 <sup>6</sup>	1x10 <sup>6</sup>						te *										
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>	1x10 <sup>5</sup>						Introductory State										
Unit Price (High)	troduct	0.3	0.3	0.3	0.2	0.3	0.3						troduct	0.02	0.01	0.01							
Unit Price (Low)	ln	0.2	0.2	0.2	0.05	0.2	0.2						In	0.01	0.01	0.01							
Years to Replacement (Life Cycle)		7	7	7	7	7	7																
Equipment Description		Short-range Vehicle to Vehicle Transceiver	Roadway Sensor I/F	Steering Actuator I/F	Turn Signal Actuator I/F	Longitudinal & Lateral Equipment Package I/F	Vehicle Speed Control Sensors							Maintenance for Processor @ 2% of Capital Cost	Maintenance for Sensors @ 5% of Capital Cost	Maintenance for Transceiver @ 2% of Capital Cost							
-	Mon-Recurring (Initial Capital Investment)															uə	ırrii M.		iser	əd	0)		

\* All prices are in thousands of 1995 dollars.

### Vehicle Toll/Parking I/F (VS19)

Quantity	State *			State *
Unit Price	Steady State *	0.02	0.02	Steady State *
Retail Price *		gy	gy	
Comparative Technology		Exist. Technology	Exist. Technology	
Quantity (High)	*	1×10 <sup>6</sup>	1x10 <sup>6</sup>	* •
Quantity (Low)	Introductory State *	1x10 <sup>5</sup>	1x10 <sup>5</sup>	Introductory State *
Unit Price (High)	roducte	0.05	0.05	roduct
Unit Price (Low)	ī	0.02	0.02	0
Years to Replacement (Life Cycle)		7	7	
Equipment Description		Active Tag Interface	Debit / Credit Card I/F	Wireless Communication via Beacon
		⋖		Recurring Mon-Recurring (Initial Capital Investmen & Maintenance)

\* All prices are in thousands of 1995 dollars.

### 5. SAMPLE EXPENDITURE CALCULATIONS - MAJOR URBAN AREA

The Phase II cost evaluation of the National ITS Architecture includes an evaluation of three separate scenarios. Each scenario represents a typical deployment area and is to provide a frame of reference for similar implementations of the architecture. A high level description of the major urban area, Urbansville, is included in the Evaluatory Design Document. A more in-depth description of Urbansville is located in the "Urban Scenario Guide, Urbansville, Phase II" scenario description document. The scenario description is a common description utilized for numerous architecture evaluation activities, including: the cost evaluation, the data loading, benefit analysis, as well as technical performance analyses. Thus, the results of the various architecture evaluation activities are all based upon one common set of assumptions. These sets of assumptions are set forth in the Evaluatory Design Document. Additional assumptions that provide greater detail and justification are provided in this Cost Analysis Document in sections 4.6.1 through 4.6.19.

The cost analysis time frame evaluates deployment milestones as specified in the Phase II Deliverable Guidelines at the five, ten and twenty year stages in the deployment. Technology selection and developmental insights are based on these milestones equating to the calendar years 1997, 2002, and 2012, respectively.

### 5.1 Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the previous sections 4.6.1 through 4.6.19. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and maintenance requirements. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology (often referenced to equipment manufacturers' estimated unit prices for comparable technology, e.g. Seimens Automotive) and developing technology (also using comparable technology and referenced to integration and systems engineering companies' and equipment manufacturers' estimated unit prices for comparable technology.)

The unit price justification is noted in the Common Equipment section of 4.6 and in the worksheets' column for "Comparative Technology." In the worksheets, where "Existing Technology" is noted, the prices represent typical unit prices for equipment found in catalogs, such as Sweet's Engineering and Retrofit, a catalog for construction cost estimating for current, off-the-shelf technology. Other references to price justification indicate specific construction bid prices for recent contracts. These prices are actual bid prices for installation. Where these two forms of justification were not available, some estimations are provided through consultations with experts in respective fields for manufacturing, and system integration. Lastly, some prices which are less certain are estimates based on professional judgement.

### 5.2 Identification and Evaluation of Quantities and Market Size

For the Equipment Package parameters, the quantity of items purchased influences the unit price for the equipment. Obviously, price breaks come into effect when larger quantities are purchased. For existing technology, many equipment prices are at a steady state price (exhibited in the far right columns of the Equipment Worksheets.) The prices are generally not subject to wide fluctuations based on quantities. Newer technology, or services which are on the front end of a market/product development curve, are subject to wide price ranges. For Urbansville, two sets of market penetrations were analyzed, a high and a low scenario. For the cost evaluation activities the low value of the unit price ranges was utilized for all Equipment Packages.

### **5.3** Calculation of Expenditures

Expenditures are calculated automatically through the linked spreadsheet programs. Included in the calculation are non-recurring expenditures (one-time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred in accordance with the Evaluatory Design Document deployment quantities for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the expenditures for asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets. This tabulation of non-recurring expenditures continues from the year of initial deployment through the analysis time frame. This evaluation is important when considering comparative technologies and life cycle costs (see previous section on life cycle costing.)

### 5.4 Results

Tabulated below are the non-recurring and recurring expenditures for an individual user for three levels of service. Basic service provides the capability for drivers to interface with the ISP Subsystem's Basic Information Broadcast Equipment Package, receive formatted traffic advisories including accurate traveling information concerning available travel options, their availability, and congestion information in their vehicle. Basic Service also provides Vehicle MAYDAY service. Mid-range Service provides the Basic services plus In-Vehicle hardware, and software for Vehicle Route Guidance and Interactive Vehicle Reception. The comprehensive Service provides the Basic and Mid-range Services plus equipment for In-Vehicle Signing, Probe Vehicle Software, Smart Probe, and Vehicle Route Guidance.

### INDIVIDUAL NON-RECURRING EXPENDITURES

Basic Service VS1, VS14 \$450 Mid-range Service Basic+VS5,VS16 \$1,350

Comprehensive Service Mid-Range+VS4, VS6, VS7, VS19 \$2,140

If all vehicle Equipment Packages including safety systems are combined, the total per vehicle non-recurring expenditure is \$8,310.

### INDIVIDUAL MONTHLY RECURRING EXPENDITURES

	$O_{\mathbf{I}}$	peration	Maintenance
Basic Service	VS1, VS14	\$10	\$1
Mid-range Service	Basic+VS5,V16	\$35	<\$5
Comprehensive Service	Mid-Range+VS4, VS6, VS7, VS1	9 \$35	<\$8

The monthly service charges for in-vehicle services are in the range of \$0 to \$43 per month for individual users (based on average usage) and are comparable to current service cost experiences for cellular telephone service.

Scenario expenditures for Mountainville are classified into likely stakeholder responsibility for funding. The resulting allocations are presented below.

### Urbansville High Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	12%
Commercial	7%
Individual	81%

### Urbansville Low Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	22%
Commercial	10%
Individual	68%

The summary expenditures for the Urbansville Equipment Packages are provided in the following pages. The non-recurring expenditures are tabulated below for the deployment milestone in the evaluation period. Note that the summations consists of the expenditures for the year stated plus the expenditures for the four previous years. The numbers presented for the recurring expenditures represent the expenditures for operation and maintenance during the deployment milestone years. Note that the non-recurring expenditures include replacement expenditures for reinvestment of equipment at the end of its' useful life.

The first of the analysis results, are for a low level market penetration, consistent with the evaluatory design parameters for deployment penetration. The second set of results are for the high level market penetration. The last results page is reflective of the government expenditures.

	Equipment Package I	Expenditu	res for L	ow Marke	<b>Expenditures for Low Market Penetration</b>	ion		
		Non-Recu	Non-Recurring Expenditures	ditures	Recurrir	Recurring Expenditures	ures	
		Yrs	Yrs	Yrs	Average Ar	Average Annual Expenditures	ditures	
EP ID	Equipment Package Name	1-5	6-10	11-20	2	10	20	
CVA1	Credentials and Taxes Administration	\$277	\$1	\$16	\$281	\$281	\$281	
CVA2	CV Information Exchange	\$22	\$0	\$0	\$77	\$77	\$77	
CVA3	CV Safety Administration	\$40	\$0	\$0	\$0	\$0	\$0	
CVA4	International CV Administration	\$41	\$0	\$0	\$136	\$136	\$136	
CVC1	Citation and Accident Electronic Recording	\$0	\$0	\$0	\$0	\$0	\$0	
CVC2	International Border Crossing	\$326	\$0	\$80	6\$	6\$	6\$	
CVC3	Roadside Electronic Screening	\$0	\$0	\$0	\$0	\$0	\$0	
CVC4	Roadside Safety Inspection	\$0	\$0	\$0	\$0	\$0	\$0	
CVC5	Roadside WIM	\$0	\$0	\$0	\$0	\$0	\$0	
CVS1	On-board Cargo Monitoring	\$0	\$150	\$733	\$0	\$394	\$1,919	
CVS2	On-board CV Electronic Data	\$38	\$378	\$2,536	\$11	\$122	\$741	
CVS3	On-board CV Safety	\$81	\$367	\$2,184	\$2	\$13	\$62	
CVS4	On-board Trip Monitoring	\$3,130	\$14,143	\$105,325	\$393	\$2,169	\$13,224	
EM1	Emergency and Incident Management Communication	\$0	\$6	\$19	\$0	\$7	\$29	
EM2	Emergency Mayday and E-911 I/F	\$105	\$105	\$420	\$2	\$2	6\$	
EM3	Emergency Response Management	\$0	\$91	\$363	\$0	\$136	\$546	
EM4	Emergency Vehicle Routing and communications	\$0	\$1	\$4	\$0	\$1	\$5	
EMM1	Emissions and Environmental Data Management	\$1	\$0	\$0	\$107	\$107	\$107	
EVS1	On-board EV Incident Management Communication	\$511	\$1,329	\$6,878	\$84	\$304	\$1,136	
EVS2	On-board Vehicle Signal Coordination	\$422	\$1,098	\$5,682	\$93	\$336	\$1,256	
FMS1	Fleet Administration	\$3,561	\$5,353	\$9,083	\$52	\$130	\$260	
FMS2	Fleet Credentials and Taxes Management and Reporting	\$3,105	\$4,813	\$8,538	\$3,421	\$8,553	\$17,105	
FMS3	Fleet HAZMAT Management	\$27	\$106	\$158	\$1	\$6	\$11	
FMS4	Freight Administration and Management	\$20	\$30	\$100	\$12	\$30	\$60	
FMS5	Fleet Maintenance Management	\$1,205	\$1,808	\$3,013	\$72	\$180	\$360	
ISP1	Basic Information Broadcast	\$422	\$1,337	\$2,312	\$316	\$1,262	\$2,524	
ISP2	EM Route Plan Information Dissemination	\$0	\$0	\$508	\$	\$0	\$22	
ISP3	Infrastructure Provided Dynamic Ridesharing	\$0	\$0	\$213	\$0	\$0	\$313	
ISP4	Infrastructure Provided Route Selection	\$0	\$350	\$2,950	\$0	\$13	\$100	
ISP5	Infrastructure Provided Yellow Pages & Reservation	\$0	\$1,068	\$1,812	\$0	\$322	\$946	
ISP6	Interactive Infrastructure Information	\$329	\$1,097	\$1,589	\$118	\$471	\$941	
ISP7	ISP Advanced Integrated Control Support	\$0	\$0	\$431	\$0	\$0	\$21	
ISP8	ISP Probe Information Collection	\$250	\$750	\$1,000	\$13	\$20	\$100	
PIA1	Personal Basic Information Reception	\$187	\$1,036	\$4,207	\$44	\$289	\$951	
PIA2	Personal Interactive Information Reception	\$20	\$269	\$3,046	\$14	\$552	\$2,118	
PIA3	Personal Mayday I/F	\$187	\$12,039	\$60,495	\$32	\$2,103	\$10,376	
PIA4	Personal Route Guidance	\$237	\$15,275	\$35,946	\$26	\$4,995	\$11,500	
PMS1	Parking Management	\$215	\$665	\$2,010	\$362	\$1,448	\$3,620	
PS1	Data Collection and ITS Planning	\$0	\$35	\$35	\$0	\$450	\$450	
	FIGURE 5.3-1 URBANSVILLE SUMMARY EQUIPMENT PACKAGE EXPENDITURES FOR LOW MARKET PENETRATION	CKAGE EXPENDIT	URES FOR LOW N	AARKET PENETRAT	NOI			181

EP ID         Equipment Package Name         1-5         4 Vrs         Average Annual Expenditures           RS11         Automate International Expenditures         Vrs         Vrs         Vrs         Average Annual Expenditures           RS11         Automate International Expenditures         Vrs         Vrs         Vrs         Average Annual Expenditures           RS11         Automate International Expenditures         SD         SD         SD         SD           RS12 (Including Expension International Expension International Expension International Expensional Expensiona		Equipment Package	Expenditu	ires for L	ow Marke	<b>Expenditures for Low Market Penetration</b>	ion		
Of Equipment Package Name         Yrs         TVS         TVS         Average Annual Expenditures           1.0         Equipment Package Name         1.5         6-10         11-20         5         10         20         50           1.0         Equipment package Name         1.5         5         6-10         5         5         10         20         50           1.0         Recovery Politic Research and Environmental Huzards Indications and Environmental Huzards Indications         \$1.20         \$1.20         \$5.0         \$1.0         \$2.0         \$1.0         \$2.0         \$1.0         \$2.0         \$1.0         \$2.0         \$1.0         \$2.0         \$1.0         \$2.0         \$1.0         \$2.0         \$1.0         \$2.0         \$1.0         \$2.0			Non-Recu	rring Expen	ditures	Recurrir	ng Expenditu	ıres	
In Equilibrium Package Name			Yrs	Yrs	Yrs	Average Ar		ditures	
Accordance in the control i	^	Equipment Package Name	1-5	6-10	11-20	Ŋ	10	20	
Occasionary Includence of the persons infinitions of the persons infinitions of the persons infinitions of the persons infinitions and the persons infinitions are also infinitely persons and the persons infinitely persons are also infinitely persons and the persons are also infinitely persons are a	RS1	Automated road signing	\$0	\$0	\$0	\$0	\$0	\$0	
Neaderway Proble Beaches   \$1,000   \$1,000   \$5.00	RS10		\$2,080	\$3,120	\$8,350	\$12	\$30	\$60	
2 (Conclored Internation Internation Disperiment Lanes         \$1,800         \$50         \$100         \$10	RS11	Roadway Probe Beacons	\$225	\$375	\$1,500	\$23	\$38	\$113	
Roadway Spetter for AHZ         \$ 10.00         \$ 1,000         \$ 1,000         \$ 10.00	RS12	Roadway Reversible Lanes	\$1,860	\$20	\$100	\$20	\$20	\$20	
Reaching Pricing   State   S	RS13	Roadway Systems for AHS	\$0	\$0	\$1,000	\$0	\$0	\$100	
Roackeey England Floringy   \$1,556   \$1,320   \$1,320   \$4,5   \$5,5   \$1,70   \$4,5   \$2,5   \$4,5   \$1,70   \$4,5   \$2,5   \$4,5   \$2,5   \$4,5   \$2,5   \$4,5   \$2,5   \$4,5   \$2,5   \$4,5   \$2,5   \$4,5   \$2,5   \$4,5   \$2,5	RS14	Roadway Traffic Information Dissemination	\$10,812	\$0	\$0	\$419	\$419	\$419	
Rouchwey Freeway Cornerd   \$500 \$11,520 \$3,3040 \$34,560 \$505 \$51729     Rouchwey Freeway Cornellative	RS2	Roadside Signal Priority	\$1,536	\$3,328	\$11,776	\$13	\$32	\$77	
Roadway House Controls   \$16,750   \$26,000   \$304,600   \$304   \$1,229   \$1,229   \$1,229   \$1,229   \$1,220   \$25,500   \$1,220   \$1,229	RS3	Roadway Freeway Control	006\$	\$1,320	\$3,090	\$45	\$66	\$89	
Remote Paste Signified   S10,176   S45,000   S128,600   S515   S10,166   S	RS4	Roadway Signal Controls	\$11,520	\$23,040	\$34,560	\$205	\$614	\$1,229	
Roadway Invitestic Signing	RS5	Roadway Basic Surveillance	\$16,750	\$45,000	\$128,600	\$910	\$3,510	\$10,166	
Readway Incleder Signing         \$0         \$200         \$525         \$0         \$100           Readway Incleder Delection System         \$0         \$1,200         \$2,700         \$30         \$10           Readway Incleder Delection System         \$0         \$1,200         \$2,700         \$50         \$1,255         \$10           Remove Interaction Collision System         \$0         \$2,756         \$0         \$1,255         \$3.76         \$10           Remove Interactive Information Reception         \$1,000         \$1,925         \$9,700         \$1,650         \$1,326         \$1,320         \$1,225         \$1,320 <td>RS6</td> <td>Roadway HOV Usage</td> <td>\$1,210</td> <td>\$20</td> <td>\$100</td> <td>\$72</td> <td>\$72</td> <td>\$72</td> <td></td>	RS6	Roadway HOV Usage	\$1,210	\$20	\$100	\$72	\$72	\$72	
Readway Incident Detection         \$600         \$1,200         \$2,700         \$50         \$180           2         Readway Incident Detection         \$0         \$80         \$50         \$156         \$156           2         Remote Instruction Collision System         \$0         \$81,200         \$1,265         \$3,765         \$3,765           2         Remote Instruction Reception         \$1,000         \$1,920         \$166         \$3,30         \$1,320           3         Remote Instruction Reception         \$1,148         \$1,000         \$1,626         \$3,30         \$1,320           4         Remote Transit Security IF         \$1,148         \$1,0328         \$2,08         \$445         \$1,600           5         Remote Transit Security IF         \$1,148         \$1,0328         \$2,08         \$445         \$1,600           1         Told Plaza Toll Collection         \$3,148         \$1,0328         \$2,08         \$445         \$549         \$445           1         Toll Plaza Toll Collection         \$1,0328         \$1,0328         \$2,03         \$1,140         \$1,140         \$1,144         \$1,0328         \$2,08         \$1,60         \$1,00         \$1,60         \$1,00         \$1,00         \$1,00         \$1,00         \$1,00	RS7	Roadway In-Vehicle Signing	\$0	\$200	\$525	\$0	\$13	\$25	
Roadway Intersection Collision System         \$0         \$2,766         \$0 </td <td>RS8</td> <td>Roadway Incident Detection</td> <td>\$600</td> <td>\$1,200</td> <td>\$2,700</td> <td>\$30</td> <td>06\$</td> <td>\$180</td> <td></td>	RS8	Roadway Incident Detection	\$600	\$1,200	\$2,700	\$30	06\$	\$180	
Remote Interactive Information Reception         \$0         \$83.32         \$3.765         \$3.765           Remote Interactive Information Reception         \$1         \$1.26         \$3.376         \$1.224           Remote Transit Security I/F         \$1.000         \$1.925         \$9.700         \$1.65         \$3.30         \$1.324           Remote Brasit Information Reception         \$1.148         \$1.200         \$5.00         \$4.88         \$9.76           Remote Transit Security I/F         \$1.148         \$1.148         \$1.200         \$5.00         \$1.920         \$1.600           Into Administration         \$1.148         \$1.148         \$1.00         \$1.60	RS9	Roadway Intersection Collision System	\$0	\$0	\$2,756	\$0	\$0	\$0	
Remote Mayday if Famore Mayday if Remote Mayday if Remote Mayday if Remote Mayday if Remote Traisif Famore Traisif Security (if Remote Basic Information Reception R.51.44 St.) 48 St.) 48.0 St.) 44.88 Sy. 78 St. 78 St.) 48.0 St.) 48.0 St. 78	RTS1	Remote Interactive Information Reception	\$0	\$830	\$3,320	\$0	\$1,255	\$3,765	
Remote Transit Fare Management         \$1,000         \$1,925         \$9,700         \$165         \$330         \$1,320           Remote Transit Face unity IF Remote Transit Security IF Security III Secu	RTS2	Remote Mayday I/F	\$3	\$8	\$40	\$16	\$31	\$124	
Remote Transit Security VF         \$0         \$600         \$1,200         \$0         \$488         \$976           Remote Basic Information Reception         \$1,448         \$1,0328         \$249         \$499         \$49 </td <td>RTS3</td> <td>Remote Transit Fare Management</td> <td>\$1,000</td> <td>\$1,925</td> <td>\$9,700</td> <td>\$165</td> <td>\$330</td> <td>\$1,320</td> <td></td>	RTS3	Remote Transit Fare Management	\$1,000	\$1,925	\$9,700	\$165	\$330	\$1,320	
Remote Basic Information Reception         \$1,148         \$1,	RTS4	Remote Transit Security I/F	\$0	\$600	\$1,200	\$0	\$488	\$976	
Toll Administration         \$56         \$10         \$60         \$49         \$49         \$49           Toll Plazar Toll Collection         \$315         \$215         \$68         \$77         \$77         \$77           Toll Plazar Toll Collection         \$725         \$526         \$520         \$1339         \$733           Toll Cert Taffic Surveillance         \$190         \$223         \$756         \$63         \$60         \$68           Toll Cert Taffic Control action         \$21         \$10         \$217         \$10         \$61         \$61         \$68           Toll Collection Discontination         \$21         \$10         \$217         \$280         \$61         \$69         \$69         \$69           Toll Collection         \$11         \$10         \$217         \$280         \$61         \$69	RTS5	Remote Basic Information Reception	\$1,148	\$1,148	\$10,328	\$208	\$415	\$1,660	
Toll Plazar Toll Collection         \$315         \$0         \$168         \$77         \$77         \$77           Collect Traffic Surveillance         \$735         \$368         \$735         \$136         \$503         \$339           Collect Traffic Surveillance         \$199         \$226         \$183         \$458         \$458           TWC Includent Coordination/Communication         \$0         \$63         \$0         \$68         \$68           TWC Includent Coordination         \$217         \$109         \$217         \$280         \$419         \$699           TWC Multi-Modal Coordination         \$217         \$109         \$217         \$280         \$419         \$699           TWC Traffic Information Dissemination         \$0         \$158         \$217         \$280         \$58         \$68           TWC Traffic Network Performance Evaluation         \$0         \$827         \$4123         \$50         \$549         \$546           TWC Traffic Network Performance Evaluation         \$0         \$827         \$4123         \$50         \$548           TWC Advanced Signal Control         \$0         \$50         \$50         \$50         \$50           TWC Basic Signal Control         \$391         \$586         \$1,561         \$460	TAS1	Toll Administration	\$26	\$10	\$60	\$49	\$49	\$49	
Collect Traffic Surveillance         \$735         \$368         \$735         \$339           TMC Incident Dispatch Coordination/Communication         \$199         \$223         \$183         \$458           TMC Incident Dispatch Coordination         \$217         \$109         \$56         \$68         \$68           TMC Multi-Modal Coordination         \$217         \$109         \$217         \$109         \$61         \$122           TMC Probe Information Dissemination         \$114         \$136         \$209         \$61         \$122           TMC Traffic Information Dissemination         \$114         \$136         \$217         \$11         \$23         \$46           TMC Traffic Information Dissemination         \$233         \$163         \$371         \$13         \$246           TMC Traffic Information Dissemination         \$23         \$163         \$239         \$258         \$258           TMC Traffic Information Dissemination         \$23         \$60         \$160         \$160         \$160         \$160           TMC Traffic Nation Dissemination         \$23         \$60         \$160         \$160         \$170         \$170         \$170           TMC Advanced Signal Control         \$0         \$0         \$0         \$0         \$0         \$17	TCS1	Toll Plaza Toll Collection	\$315	\$0	\$168	\$77	\$77	\$77	
TWC Incident Dispatch Coordination/Communication         \$199         \$232         \$755         \$92         \$183         \$458           TMC Input to In-Vehicle Signing         \$0         \$0         \$60         \$60         \$69         \$69           TMC Input to In-Vehicle Signing         \$217         \$109         \$217         \$280         \$619         \$699           TMC Muti-Modal Coordination         \$114         \$136         \$217         \$11         \$12         \$12           TMC Traffic Information Dissemination         \$233         \$163         \$317         \$11         \$12         \$12           TMC Traffic Neuronce Evaluation         \$0         \$823         \$239         \$239         \$598           TMC Traffic Neuronce Evaluation         \$0         \$82         \$12         \$246         \$12           TMC Traffic Neuronce Evaluation         \$0         \$60         \$180         \$10         \$10           TMC Traffic Neuronce Evaluation         \$0         \$823         \$10         \$10         \$10           Traffic Nationeance         \$0         \$0         \$0         \$0         \$0         \$10           TMC Regional Traffic Control         \$0         \$10         \$10         \$10         \$11         <	TMS1	Collect Traffic Surveillance	\$735	\$368	\$735	\$136	\$203	\$339	
TMC Input to In-Vehicle Signing         \$0         \$63         \$68         \$68           TMC Multi-Modal Coordination         \$217         \$109         \$217         \$280         \$419         \$699           TMC Multi-Modal Coordination         \$114         \$158         \$217         \$11         \$523         \$466           TMC Toli/Parking Coordination         \$136         \$317         \$11         \$23         \$466           TMC Toli/Parking Coordination         \$0         \$163         \$371         \$239         \$588           TMC Taffic Information Dissemination         \$0         \$82         \$413         \$239         \$588           TMC Taffic Network Performance Evaluation         \$0         \$82         \$412         \$588         \$428         \$588           TMC Taffic Network Performance Evaluation         \$0         \$60         \$60         \$60         \$60         \$60         \$60         \$60           TMC Taffic Network Performance Evaluation         \$0         \$60	TMS10	TMC Incident Dispatch Coordination/Communication	\$199	\$232	\$755	\$92	\$183	\$458	
TMC Multi-Model Coordination         \$217         \$109         \$217         \$699         \$699           TMC Probe Information Collection         \$0         \$158         \$209         \$61         \$122           TMC Probe Information Collection         \$14         \$136         \$217         \$14         \$126           TMC Traffic Information Dissemination         \$14         \$136         \$317         \$139         \$239         \$46           TMC Traffic Information Dissemination         \$0         \$827         \$146 </td <td>TMS11</td> <td>TMC Input to In-Vehicle Signing</td> <td>\$0</td> <td>\$0</td> <td>\$63</td> <td>\$0</td> <td>\$0</td> <td>\$68</td> <td></td>	TMS11	TMC Input to In-Vehicle Signing	\$0	\$0	\$63	\$0	\$0	\$68	
TWC Probe Information Collection         \$0         \$158         \$209         \$0         \$122           TMC Toli/Parking Coordination         \$114         \$136         \$317         \$11         \$23         \$46           TMC Toli/Parking Coordination         \$233         \$163         \$371         \$23         \$46           TMC Traffic Information Dissemination         \$0         \$823         \$437         \$588         \$588           TMC Traffic Information Dissemination         \$0         \$60         \$497         \$548         \$548           TMC Traffic Network Performance Evaluation         \$0         \$60         \$180         \$270         \$486           TMC Traffic Network Performance Evaluation         \$0         \$60         \$6         \$6         \$6           TMC Advanced Signal Control         \$0         \$0         \$0         \$0         \$0         \$0           TMC Based Freeway Control         \$0         \$391         \$1,687         \$0         \$0         \$0           TMC Basic Signal Control         \$0         \$0         \$21         \$0         \$0         \$0           TMC HOV/Reversible Lane Management         \$604         \$7         \$1,935         \$1,935         \$1,935         \$1,935         \$1,935	TMS12	TMC Multi-Modal Coordination	\$217	\$109	\$217	\$280	\$419	669\$	
TMC Toll/Parking Coordination         \$114         \$136         \$317         \$11         \$23         \$46           TMC Traffic Information Dissemination         \$233         \$163         \$371         \$239         \$598           TMC Traffic Network Performance Evaluation         \$0         \$827         \$4,233         \$0         \$497         \$2,485           Traffic Nation and Evaluation         \$0         \$60         \$160         \$160         \$270         \$450           Traffic Nation and Evaluation         \$0         \$60         \$160         \$160         \$160         \$160           TMC Advanced Signal Control         \$0         \$0         \$0         \$0         \$0         \$140         \$140           TMC Advanced Signal Control         \$0         \$0         \$0         \$0         \$0         \$0         \$140         \$140           TMC Basic Signal Control         \$0         \$1,087         \$0         \$0         \$0         \$1,149         \$1,149         \$1,149         \$1,149         \$1,149         \$1,149         \$1,149         \$1,149         \$1,149         \$1,140         \$1,140         \$1,140         \$1,140         \$1,140         \$1,140         \$1,140         \$1,140         \$1,140         \$1,140         \$1,14	TMS13	TMC Probe Information Collection	\$0	\$158	\$209	\$0	\$61	\$122	
TMC Traffic Methormation Dissemination         \$233         \$163         \$371         \$239         \$598           TMC Traffic Network Performance Evaluation         \$0         \$827         \$4,233         \$0         \$497         \$2,485           Traffic Maintenance         \$40         \$60         \$160         \$180         \$270         \$450           Distributed Road Management         \$0         \$0         \$0         \$0         \$0         \$0         \$0           TMC Advanced Signal Control         \$0	TMS14	TMC Toll/Parking Coordination	\$114	\$136	\$317	\$11	\$23	\$46	
S TMC Traffic Network Performance Evaluation         \$0         \$827         \$4,233         \$0         \$497         \$2,485           7 Traffic Maintenance         \$1         \$60         \$160         \$180         \$270         \$450           80         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0           1 Info Advanced Signal Control         \$0         \$2623         \$0	TMS15	TMC Traffic Information Dissemination	\$233	\$163	\$371	\$239	\$329	\$598	
7         Traffic Maintenance         \$40         \$60         \$160         \$180         \$270         \$450           Distributed Road Management         \$0         \$0         \$0         \$0         \$0         \$0         \$0           TMC Advanced Signal Control         \$0         \$2623         \$0         \$0         \$912         \$0 </td <td>TMS16</td> <td>TMC Traffic Network Performance Evaluation</td> <td>\$0</td> <td>\$827</td> <td>\$4,233</td> <td>\$0</td> <td>\$497</td> <td>\$2,485</td> <td></td>	TMS16	TMC Traffic Network Performance Evaluation	\$0	\$827	\$4,233	\$0	\$497	\$2,485	
Distributed Road Management         \$0 <t< td=""><td>TMS17</td><td>Traffic Maintenance</td><td>\$40</td><td>\$60</td><td>\$160</td><td>\$180</td><td>\$270</td><td>\$450</td><td></td></t<>	TMS17	Traffic Maintenance	\$40	\$60	\$160	\$180	\$270	\$450	
TMC Advanced Signal Control         \$0         \$623         \$0         \$912           TMC Regional Traffic Control         \$0         \$364         \$1,087         \$0         \$205         \$614           TMC based Freeway Control         \$391         \$586         \$1,561         \$460         \$689         \$1,149           TMC based Freeway Control         \$3391         \$390         \$780         \$982         \$982           TMC Basic Signal Control         \$0         \$0         \$271         \$0         \$982           TMC Con AHS         \$0         \$271         \$0         \$598           TMC Incident Detection         \$462         \$332         \$1,529         \$1,935         \$534           TMC Incident Detection         \$121         \$121         \$121         \$121         \$121         \$121	TMS2	Distributed Road Management	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Regional Traffic Control         \$0         \$364         \$1,087         \$0         \$205         \$614           TMC based Freeway Control         \$391         \$586         \$1,561         \$460         \$689         \$1,149           TMC Basic Signal Control         \$391         \$390         \$780         \$982         \$982           TMC Rasic Signal Control         \$0         \$0         \$771         \$0         \$982           TMC for AHS         \$0         \$271         \$0         \$598           TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$1,935         \$534           TMC Incident Detection         \$604         \$727         \$1,878         \$1,935         \$3,225           Fleet Maintenance Management         \$121         \$121         \$121         \$124         \$22	TMS3	TMC Advanced Signal Control	\$0	\$0	\$623	\$0	\$0	\$912	
TMC based Freeway Control         \$391         \$586         \$1,561         \$460         \$689         \$1,149           TMC Basic Signal Control         \$391         \$390         \$780         \$982         \$982           TMC Rosic Signal Control         \$0         \$0         \$0         \$0         \$982           TMC for AHS         \$0         \$0         \$0         \$0         \$598           TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320         \$534           TMC Incident Detection         \$604         \$727         \$1,878         \$1,935         \$3,225           Fleet Maintenance Management         \$121         \$121         \$124         \$22	TMS4	TMC Regional Traffic Control	\$0	\$364	\$1,087	\$0	\$205	\$614	
TMC Basic Signal Control         \$391         \$390         \$780         \$982         \$982           TMC for AHS         \$0         \$271         \$0         \$598           TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320         \$534           TMC HOV/Reversible Lane Management         \$604         \$727         \$1,878         \$1,290         \$1,935         \$3,225           Fleet Maintenance Management         \$121         \$121         \$12         \$14         \$22	TMS5	TMC based Freeway Control	\$391	\$586	\$1,561	\$460	\$689	\$1,149	
TMC for AHS         \$0         \$0         \$0         \$598           TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320         \$534           TMC Incident Detection         \$604         \$727         \$1,878         \$1,290         \$1,935         \$3,225           Fleet Maintenance Management         \$121         \$121         \$12         \$14         \$22	TMS6	TMC Basic Signal Control	\$391	\$390	\$780	\$982	\$982	\$982	
TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320         \$534           TMC Incident Detection         \$604         \$727         \$1,878         \$1,290         \$1,935         \$3,225           Fleet Maintenance Management         \$121         \$121         \$121         \$12         \$12	TMS7	TMC for AHS	\$0	\$0	\$271	\$0	\$0	\$598	
TMC Incident Detection         \$604         \$727         \$1,878         \$1,290         \$1,935         \$3,225           Fleet Maintenance Management         \$121         \$121         \$121         \$124         \$22	TMS8	TMC HOV/Reversible Lane Management	\$462	\$332	\$1,529	\$214	\$320	\$534	
Fleet Maintenance Management         \$121         \$121         \$7         \$14         \$22	EWIZ9	TMC Incident Detection	\$604	\$727	\$1,878	\$1,290	\$1,935	\$3,225	
	TRM1	Fleet Maintenance Management	\$121	\$121	\$121	\$2	\$14	\$22	

	Non-Reci	Non-Recurring Expenditures	difures	Recurri	Recurring Expenditures	Ires
	Yrs	Yrs	Yrs	Average A	Average Annual Expenditures	ditures
EP ID Equipment Package Name	1-5	6-10	11-20	2	10	20
TRM2 Transit Center Fare and Load Management	\$292	\$292	\$292	2\$	\$14	\$20
TRM3 Transit Center Fixed-Route Operations	\$249	\$249	\$249	\$231	\$462	\$694
TRM4 Transit Center Multi-Modal Coordination	\$0	\$235	\$128	\$0	\$20	\$104
Transit Center Paratransit Operations	\$140	\$140	\$140	\$1	\$2	\$2
FRM6 Transit Center Security	\$321	\$321	\$461	\$205	\$409	\$614
Transit Center Tracking and Dispatch	\$	\$1,694	\$877	\$0	\$535	\$802
FRV1 On-board Maintenance	\$0	\$1,634	\$3,017	\$0	\$811	\$1,497
TRV2 On-board Transit Driver I/F	\$2,493	\$3,122	\$10,653	\$553	\$1,222	\$2,257
TRV3 On-board Transit Fare and Load Management	\$658	\$794	\$2,682	\$773	\$1,706	\$3,151
TRV4 On-board Transit Security	\$	\$2,481	\$9,164	\$0	\$236	\$872
PRV5 On-board Vehicle Signal Coordination	\$	\$575	\$2,123	\$0	\$18	29\$
TRV6 Vehicle Dispatch Support	\$0	\$0	\$0	66\$	\$218	\$402
On-board Trip Monitoring	\$466	\$563	\$1,900	\$733	\$1,619	\$2,990
Basic Vehicle Reception	\$3,555	\$15,844	\$123,177	\$0	\$0	\$0
Vehicle Lateral Control	\$0	\$0	\$23,924	\$0	\$0	\$478
Vehicle Lateral Warning System	\$0	\$0	\$41,868	\$0	\$0	\$1,196
Vehicle Longitudinal Control	\$0	\$0	\$17,943	\$0	\$0	\$1,196
Vehicle Longitudinal Warning System	\$0	\$33,948	\$209,339	\$0	\$970	\$5,981
Vehicle Mayday I/F	\$13,332	\$25,466	\$103,048	\$6,933	\$20,175	\$46,653
Vehicle Pre-Crash Safety Systems	\$0	\$0	\$26,316	\$0	\$0	\$957
VS16 Vehicle Route Guidance	\$4,266	\$26,772	\$99,964	\$1,813	\$13,191	\$40,671
Vehicle Safety Monitoring System	\$4,622	\$20,597	\$160,130	\$356	\$1,940	\$11,962
Vehicle Systems for AHS	\$0	\$0	\$2,512	\$0	\$0	\$72
Vehicle Toll/Parking I/F	\$711	\$841	\$10,281	\$0	\$0	\$0
Driver Safety Monitoring System	\$0	\$8,342	\$102,875	\$0	\$582	\$7,177
Driver Visibility Improvement System	\$0	\$0	\$28,709	\$0	\$0	\$1,435
In-Vehicle Signing System	\$0	\$3,104	\$38,279	\$0	\$194	\$2,392
Interactive Vehicle Reception	\$533	\$5,286	\$17,280	\$320	\$3,492	\$10,048
Probe Vehicle Software	\$88	\$881	\$2,481	\$18	\$194	\$478
Smart Probe	\$0	\$0	\$0	\$0	\$0	\$0
Vehicle Intersection Collision Warning	\$0	\$0	\$957	\$0	\$0	\$120
Vehicle Intersection Control	<b>%</b>	\$0	\$4,785	\$0	\$0	\$239

December of the proposition of the propositio		Equipment Fackage	ckage Expenditures for nign market Penetration	es ior nigr	ואומו אכו רכ	וובוומוום			
Conclusion and Administration         Yrs         FVS         FVS         Average Annual Expenditures           Conclusing and Taxes Administration         4.5         6.10         11.20         5.0         5.0         5.0         20.0           Conclusing and Taxes Administration         \$2.77         6.10         5.0			Non-Rect	urring Expen	ditures	Recurrin	ıg Expendit	ures	
Concentiate and Tackey Administration   1-5   6-10   11-20   5-11   5-			Yrs	Yrs	Yrs	Average A	ınual Expen	ditures	
CV Information Fectoring			1-5	6-10	11-20	2	10	20	
CV intervalue from the continuent of continuents of continuents of continuents and the continuents of continuents of continuents and the continuents of continuents of continuents and the continuents of continuents and the continuents of continuents and the continuents of continuents and continu	CVA1	Credentials and Taxes Administration	\$277	\$1	\$16	\$281	\$281	\$281	
Performance	CVA2	CV Information Exchange	\$22	\$0	\$0	\$77	\$77	\$77	
Internation and Activate Heatmenth	CVA3	CV Safety Administration	\$40	\$0	\$0	\$0	\$0	\$0	
International Bordetic Creating   \$5.00   \$5	CVA4	International CV Administration	\$41	\$0	\$0	\$136	\$136	\$136	
Promision Dissolution Control Contro	CVC1	Citation and Accident Electronic Recording	\$0	\$0	\$0	\$0	\$0	\$0	
Productive Energeting Script State   State Sta	CVC2	International Border Crossing	\$326	\$0	\$80	6\$	6\$	6\$	
Production bending   Signature   Signatu	CVC3	Roadside Electronic Screening	\$0	\$0	\$0	\$	\$0	\$0	
Readsale VMM         Readsale VMM         STORED STO	CVC4	Roadside Safety Inspection	\$0	\$0	\$0	\$0	\$0	\$0	
On-board clargo Montioning         \$136         \$166         \$1833         \$557         \$784         \$4798           On-board Clargo Montioning         \$162         \$756         \$164         \$22         \$243         \$1186           On-board VS Selectors Montioned Management Communication         \$162         \$576         \$526         \$549         \$516         \$589         \$15         \$526         \$598           Ennegatory Mayday and E-811 if The Montionitient Management Communications         \$162         \$261         \$516         \$527         \$52 <td>CVC5</td> <td>Roadside WIM</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td></td>	CVC5	Roadside WIM	\$0	\$0	\$0	\$0	\$0	\$0	
On-board Vox Rection in Data         \$75         \$756         \$8,165         \$243         \$8,1186           On-board Tip Montedring         \$7,626         \$26,719         \$168,520         \$983         \$4,337         \$21,159           On-board Tip Montedring         \$7,626         \$26,719         \$168,520         \$983         \$4,337         \$21,159           Emergency Mexical and Incident Management Communication         \$12         \$26         \$6         <	CVS1	On-board Cargo Monitoring	\$136	\$165	\$1,833	\$357	\$787	\$4,798	
On-board Vor Salley         \$172.         \$7.327         \$5.6         \$9.4           Enneygancy and Incident Management Communication         \$7,826         \$26,520         \$9.83         \$4.337         \$21,156           Enneygancy Add Incident Management Communications         \$7,826         \$2.40         \$5.9         \$5.9           Enneygancy Response And Incident Management Communications         \$2.1         \$2.1         \$2.2         \$2.9           Enneygancy Vehicle Routing and communications         \$2.1         \$2.1         \$2.2         \$2.9           Enneygancy Vehicle Routing and communications         \$2.1         \$2.1         \$2.2         \$2.9           Con-board Vehicle Signal Coordination         \$1.02         \$2.66         \$2.68         \$1.07         \$1.05           On-board Vehicle Signal Coordination         \$8.45         \$2.16         \$5.68         \$1.07         \$1.26           On-board Vehicle Signal Coordination         \$8.45         \$2.196         \$5.682         \$1.07         \$1.26           On-board Vehicle Signal Coordination         \$1.02         \$2.196         \$5.682         \$1.07         \$1.02           Feet Administration         \$1.02         \$2.196         \$2.14         \$1.07         \$1.02           Feet HAZMAT Management         \$	CVS2	On-board CV Electronic Data	\$75	\$756	\$4,057	\$22	\$243	\$1,186	
On-board Trip Monitoring         \$7.826         \$26,719         \$168.50         \$983         \$4,337         \$21,159           Energency and Incident Management Communication         \$12         \$20         \$6	CVS3	On-board CV Safety	\$162	\$734	\$3,277	\$5	\$26	\$94	
Emergency and Incident Management Communication         \$12         \$6         \$15         \$29         \$19           Emergency Analyzy and Incident Management Communications         \$210         \$210         \$400         \$56         \$50	CVS4	On-board Trip Monitoring	\$7,826	\$26,719	\$168,520	\$983	\$4,337	\$21,159	
Energetroy Mayday and E-B11 UF         \$210         \$210         \$36         \$56           Energetroy Resource Management         \$182         \$21         \$36         \$573         \$409         \$564           Energetroy Resource and Environmental Data Management         \$2         \$2         \$2         \$4         \$56           Enrissions and Environmental Data Management         \$1022         \$2,689         \$6,870         \$107         \$107           On-board EV Incident Management Communication         \$84,80         \$2,168         \$5,682         \$11,036         \$11,136           On-board Velloger Resolution on Name Management         \$8,903         \$6,930         \$12,824         \$100         \$11,036         \$11,136           Fleet Administration         \$8,903         \$6,930         \$12,824         \$100         \$2,405         \$11,036         \$1,136 <td< td=""><td>EM1</td><td>Emergency and Incident Management Communication</td><td>\$12</td><td>\$6</td><td>\$8</td><td>\$15</td><td>\$22</td><td>\$29</td><td></td></td<>	EM1	Emergency and Incident Management Communication	\$12	\$6	\$8	\$15	\$22	\$29	
Emergene of Management Tonk Management Concludation         \$18.2         \$9.1         \$36.6         \$6.6           Emergene Verlace Routing and communications         \$2         \$2         \$4         \$5.6           Con-board Environmental Data Management Communication         \$1,022         \$2,659         \$6.877         \$1136           On-board Vehicle Routing and Communication         \$1,022         \$2,659         \$6.876         \$1137         \$1,136           On-board Vehicle Signal Condition         \$84.5         \$2,166         \$5.868         \$1137         \$1,136           On-board Vehicle Signal Coordination         \$8.903         \$2,164         \$187         \$600         \$1,136           Fleet NAZMA Management         \$8.903         \$1,2418         \$8,553         \$17,105         \$29,072           Fleet HAZMAN Management         \$1,33         \$1,33         \$1,33         \$1,33         \$1,105         \$1,105           Fleet HAZMAN Management         \$1,33         \$1,33         \$1,33         \$1,105         \$1,105         \$1,105           Fleet HAZMAN Management         \$1,03         \$1,33         \$1,33         \$1,33         \$1,21         \$1,26         \$1,26           Fleet HAZMAN Management         \$1,03         \$1,33         \$1,33         \$1,33 <td>EM2</td> <td>Emergency Mayday and E-911 I/F</td> <td>\$210</td> <td>\$210</td> <td>\$420</td> <td>\$2</td> <td>6\$</td> <td>6\$</td> <td></td>	EM2	Emergency Mayday and E-911 I/F	\$210	\$210	\$420	\$2	6\$	6\$	
Emergency Vehicle Routing and communications         \$2         \$3         \$4         \$5           Emissions and Environmental Data Management         \$1         \$2         \$5         \$6         \$107         \$107         \$107           On-board Vehicle Signal Coordination         \$1         \$2         \$2.568         \$6.818         \$1.408         \$1.266           On-board Vehicle Signal Coordination         \$6.82         \$2.196         \$5.682         \$187         \$57.26         \$1.266           On-board Vehicle Signal Coordination         \$1.022         \$2.196         \$5.682         \$187         \$57.26         \$1.266           On-board Vehicle Signal Coordination         \$1.022         \$2.196         \$5.682         \$187         \$57.26         \$1.266           Fleet Character Administration         \$1.022         \$2.196         \$5.683         \$1.02	EM3	Emergency Response Management	\$182	\$91	\$361	\$273	\$409	\$546	
Emissions and Environmental Data Management	EM4	Emergency Vehicle Routing and communications	\$2	\$2	\$3	\$2	\$4	\$5	
On-board EV Incident Management Communication         \$1,022         \$2,669         \$6,878         \$169         \$608         \$1,136           On-board Vahiele Signal Coordination         \$8455         \$2,166         \$5,682         \$187         \$602         \$1,256           Fleet Credentials and Taxes Management and Reporting         \$7,763         \$8,150         \$12,418         \$8,553         \$17,105         \$29,079           Fleet HAZMAT Management         \$133         \$133         \$133         \$183         \$51         \$20,079           Fleet HAZMAT Management         \$133         \$133         \$148         \$56         \$17         \$17           Fleet HAZMAT Management         \$133         \$133         \$148         \$56         \$10         \$10           Fleet HAZMAT Management         \$133         \$133         \$14         \$10	EMM1	Emissions and Environmental Data Management	\$1	\$0	\$0	\$107	\$107	\$107	
On-board Vehicle Signal Coordination         \$845         \$2,196         \$5,682         \$187         \$1256           Fleet Administration         \$8,903         \$12,824         \$130         \$12,824         \$100         \$142           Fleet HAZMAT Management         \$133         \$133         \$134         \$156         \$17,105         \$17,105         \$17,105         \$17,105         \$17,105         \$17,105         \$17,105         \$17,105         \$102	EVS1	On-board EV Incident Management Communication	\$1,022	\$2,659	\$6,878	\$169	\$608	\$1,136	
Fleet Administration         \$8,903         \$12,824         \$130         \$260         \$442           Fleet Credentials and Taxes Management and Reporting         \$7,763         \$8,160         \$12,418         \$8,553         \$17,105         \$29,079           Fleet HAZMAT Management         \$133         \$133         \$12,418         \$8,553         \$17,105         \$29,079           Fleet HAZMAT Management         \$50         \$133         \$20         \$170         \$30         \$102           Fleet Maintenance Management         \$5,013         \$2,013         \$4,218         \$180         \$530         \$612           Easic Information Bissemination         \$0         \$1,22         \$1,37         \$2,312         \$180         \$52           Basic Information Bissemination         \$0         \$1,037         \$1,267         \$1,66         \$1,06           Infrastructure Provided Vallow Pages & Reservation         \$1,060         \$1,060         \$1,467         \$14         \$4,107           Infrastructure Provided Vallow Pages & Reservation         \$356         \$1,007         \$1,467         \$41         \$47           Infrastructure Provided Vallow Pages & Reservation         \$356         \$1,007         \$1,108         \$1,108         \$1,108         \$1,108         \$1,108	EVS2	On-board Vehicle Signal Coordination	\$845	\$2,196	\$5,682	\$187	\$672	\$1,256	
Fleet Credentials and Taxes Management and Reporting \$7,763 \$8,150 \$12,418 \$8,553 \$17,105 \$29,079     Fleet HAZMAT Management \$133 \$133 \$133 \$14 \$170 \$102     Fleet HAZMAT Management \$13,013 \$1,030 \$1,030 \$1,030 \$1,02	FMS1	Fleet Administration	\$8,903	\$8,930	\$12,824	\$130	\$260	\$442	
Fleet HAZMAT Management         \$133         \$133         \$133         \$183         \$61         \$17           Freight Administration and Management         \$50         \$50         \$170         \$30         \$102           Freight Administration and Management         \$5,013         \$5,013         \$412         \$180         \$360         \$102           Basic Information Dissemination         \$0         \$1,37         \$4,312         \$180         \$262         \$2,524           EM Route Plan Information Dissemination         \$0         \$1,37         \$4,35         \$0         \$152         \$2,524           EM Route Plan Information Dissemination         \$0         \$1,07         \$1,06         \$3,65         \$100         \$100           Infrastructure Provided Dynamic Ricesharing         \$0         \$1,06         \$3,250         \$1,06         \$3,65         \$100           Infrastructure Provided Route Selection         \$356         \$1,073         \$1,167         \$1467         \$1467         \$140           Infrastructure Provided Route Selection         \$356         \$1,073         \$1,128         \$1,167         \$9,41         \$100           Infrastructure Information Reception         \$1,087         \$1,087         \$1,087         \$1,087         \$1,087         \$1,0	FMS2	Fleet Credentials and Taxes Management and Reporting	\$7,763	\$8,150	\$12,418	\$8,553	\$17,105	\$29,079	
Freight Administration and Management         \$50         \$50         \$102           Fleet Maintenance Management         \$3.013         \$3.013         \$4.218         \$180         \$50         \$102           Fleet Maintenance Management         \$3.013         \$3.013         \$3.013         \$5.254         \$5.624           Basic Information Broadcast         \$0         \$1.37         \$2.312         \$1.62         \$2.524           EM Route Plan Information Dissemination         \$0         \$1.05         \$1.265         \$0         \$1.05           Infrastructure Provided Pouna Dissemination         \$0         \$1.05         \$3.250         \$0         \$1.06           Infrastructure Provided Pouna Provided Pouna Pages & Reservation         \$3.55         \$1.073         \$1.467         \$1.18         \$4.71         \$9.41           Infrastructure Information         \$3.55         \$1.073         \$1.589         \$1.18         \$4.71         \$9.41           IsP Advanced Integrated Control Support         \$1.087         \$1.087         \$1.189         \$1.18         \$4.71         \$9.41           IsP Probe Information Reception         \$1.087         \$3.023         \$4.07         \$4.207         \$4.207         \$4.207           Personal Basic Information Reception         \$2.369	FMS3	Fleet HAZMAT Management	\$133	\$133	\$183	\$6	\$11	\$17	
Freet Maintenance Management	FMS4	Freight Administration and Management	\$20	\$20	\$170	\$30	\$60	\$102	
Basic Information Broadcast         \$422         \$1,37         \$2,312         \$316         \$1,262         \$2,524           EM Route Plan Information Dissemination         \$0         \$127         \$435         \$0         \$16         \$22           Infrastructure Provided Dynamic Ridesharing         \$0         \$106         \$1,650         \$1,650         \$1,66	FMS5	Fleet Maintenance Management	\$3,013	\$3,013	\$4,218	\$180	\$360	\$612	
EM Route Plan Information Dissemination         \$0         \$127         \$435         \$0         \$156         \$22           Infrastructure Provided Dynamic Ridesharing         \$0         \$106         \$543         \$0         \$156         \$938           Infrastructure Provided Route Selection         \$0         \$1,050         \$1,050         \$1,060         \$3,250         \$0         \$100           Infrastructure Provided Yellow Pages & Reservation         \$356         \$1,073         \$1,467         \$118         \$471         \$946           Interactive Infrastructure Information         \$356         \$1,073         \$1,467         \$1,128         \$0         \$10           ISP Advanced Integrated Control Support         \$0         \$216         \$1,007         \$1,128         \$0         \$10         \$10           ISP Advanced Integrated Control Support         \$0         \$1,128         \$0         \$10	ISP1	Basic Information Broadcast	\$422	\$1,337	\$2,312	\$316	\$1,262	\$2,524	
\$106         \$543         \$0         \$156         \$938           Infrastructure Provided Route Selection         \$0         \$1,050         \$3,250         \$0         \$38         \$100           Infrastructure Provided Route Selection         \$356         \$1,073         \$1,467         \$118         \$473         \$946           Interactive Infrastructure Information         \$356         \$1,097         \$1,689         \$118         \$471         \$941           ISP Advanced Integrated Control Support         \$0         \$1,097         \$1,689         \$1,18         \$471         \$62           ISP Advanced Integrated Control Support         \$0         \$1,007         \$1,000	ISP2	EM Route Plan Information Dissemination	\$0	\$127	\$435	\$0	\$6	\$22	
Infrastructure Provided Route Selection         \$0         \$1,050         \$3,250         \$0         \$100           Infrastructure Provided Yellow Pages & Reservation         \$356         \$1,073         \$1,467         \$118         \$473         \$946           Interactive Infrastructure Information         \$359         \$1,097         \$1,689         \$118         \$471         \$941           ISP Advanced Integrated Control Support         \$0         \$216         \$1,128         \$0         \$10         \$10           ISP Advanced Integrated Control Support         \$250         \$750         \$1,000         \$13         \$62         \$10           ISP Probe Information Reception         \$1,867         \$3,023         \$42,072         \$442         \$1,157         \$9,511           Personal Basic Information Reception         \$1,144         \$6,686         \$141         \$9,20         \$1,383           Personal Interactive Information Reception         \$1,174         \$6,686         \$1,47         \$1,383           Personal Mayday I/F         \$1,174         \$6,686         \$1,47         \$1,467         \$1,87           Parking Management         \$2,369         \$2,584         \$2,534         \$6,516         \$2,534         \$6,516           Data Collection and ITS Planning	ISP3	Infrastructure Provided Dynamic Ridesharing	\$0	\$106	\$543	\$0	\$156	\$938	
Intrastructure Provided Yellow Pages & Reservation         \$356         \$1,073         \$1,467         \$118         \$473         \$946           Interactive Infrastructure Information         \$359         \$1,097         \$1,589         \$118         \$471         \$941           ISP Advanced Integrated Control Support         \$0         \$1,097         \$1,28         \$0         \$10         \$62           ISP Advanced Integrated Control Support         \$250         \$750         \$1,000         \$13         \$50         \$10           ISP Probe Information Reception         \$1,867         \$3,023         \$42,072         \$44.2         \$1,167         \$9,511           Personal Basic Information Reception         \$1,867         \$2,284         \$82,277         \$4,539         \$4,539           Personal Mayday I/F         \$1,144         \$6,686         \$141         \$9,901         \$24,642           Personal Route Guidance         \$2,369         \$2,865         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$6,556         \$3,023         \$3,625         \$1,086         \$2,534         \$6,516           Data Collection and ITS Planning         \$35         \$35         \$35         \$450         \$450	ISP4	Infrastructure Provided Route Selection	\$0	\$1,050	\$3,250	\$0	\$38	\$100	
Interactive Infrastructure Information         \$359         \$1,097         \$1589         \$118         \$471         \$941           ISP Advanced Integrated Control Support         \$0         \$1,00         \$13         \$0         \$10         \$10           ISP Probe Information Collection         \$1,167         \$1,000         \$13         \$50         \$10         \$10           Personal Basic Information Reception         \$1,187         \$3,023         \$42,072         \$442         \$1,157         \$9,511           Personal Interactive Information Reception         \$1,186         \$2,584         \$82,777         \$321         \$4,539           Personal Mayday I/F         \$1,867         \$22,584         \$82,277         \$13,834         \$13,834           Personal Route Guidance         \$2,369         \$28,655         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$645         \$35         \$36,257         \$1,086         \$2,534         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$35         \$450         \$450	ISP5	Infrastructure Provided Yellow Pages & Reservation	\$326	\$1,073	\$1,467	\$118	\$473	\$946	
ISP Advanced Integrated Control Support         \$0         \$216         \$1,128         \$0         \$10         \$62           ISP Probe Information Collection         \$1,186         \$1,000         \$13         \$50         \$100           Personal Basic Information Reception         \$1,187         \$3,023         \$42,072         \$442         \$1,157         \$9,511           Personal Interactive Information Reception         \$1,114         \$6,686         \$141         \$920         \$4,539           Personal Interactive Information Reception         \$1,186         \$22,584         \$82,277         \$321         \$4,207         \$13,834           Personal Route Guidance         \$2,369         \$28,655         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$645         \$35         \$1,086         \$2,534         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450	ISP6	Interactive Infrastructure Information	\$329	\$1,097	\$1,589	\$118	\$471	\$941	
ISP Probe Information Collection         \$1,000         \$13         \$50         \$100           Personal Basic Information Reception         \$1,867         \$3,023         \$42,072         \$442         \$1,157         \$9,511           Personal Interactive Information Reception         \$2.01         \$1,114         \$6,686         \$141         \$920         \$4,539           Personal Interactive Information Reception         \$1,867         \$22,584         \$82,277         \$321         \$4,207         \$13,834           Personal Route Guidance         \$2,369         \$28,655         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$6,516         \$3,534         \$6,516         \$6,516         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450         \$450	ISP7	ISP Advanced Integrated Control Support	\$0	\$216	\$1,128	\$0	\$10	\$62	
Personal Basic Information Reception         \$1,867         \$3,023         \$42,072         \$442         \$1,157         \$9,511           Personal Interactive Information Reception         \$201         \$1,114         \$6,686         \$141         \$920         \$4,539           Personal Interactive Information Reception         \$1,867         \$22,584         \$82,277         \$321         \$4,207         \$13,834           Personal Route Guidance         \$2,369         \$28,655         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$645         \$9,90         \$3,534         \$6,516         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450	ISP8	ISP Probe Information Collection	\$250	\$120	\$1,000	\$13	\$20	\$100	
Personal Interactive Information Reception         \$201         \$1,114         \$6,686         \$141         \$920         \$4,539           Personal Mayday I/F         \$1,867         \$22,584         \$82,277         \$321         \$4,207         \$13,834           Personal Route Guidance         \$2,369         \$2,8655         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$645         \$920         \$3,625         \$1,086         \$2,534         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450         \$450	PIA1	Personal Basic Information Reception	\$1,867	\$3,023	\$42,072	\$442	\$1,157	\$9,511	
Personal Mayday I/F         \$1,867         \$22,584         \$82,277         \$321         \$4,207         \$13,834           Personal Route Guidance         \$2,369         \$2,8655         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$645         \$920         \$3,625         \$1,086         \$2,534         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450         \$450	PIA2	Personal Interactive Information Reception	\$201	\$1,114	\$6,686	\$141	\$920	\$4,539	
Personal Route Guidance         \$2,369         \$28,655         \$78,889         \$763         \$9,991         \$24,642           Parking Management         \$645         \$920         \$3,625         \$1,086         \$2,534         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450         \$450	PIA3	Personal Mayday I/F	\$1,867	\$22,584	\$82,277	\$321	\$4,207	\$13,834	
Parking Management         \$645         \$920         \$3,625         \$1,086         \$2,534         \$6,516           Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450         \$450	PIA4	Personal Route Guidance	\$2,369	\$28,655	\$78,889	\$763	\$9,991	\$24,642	
Data Collection and ITS Planning         \$0         \$35         \$35         \$0         \$450         \$450	PMS1	Parking Management	\$645	\$920	\$3,625	\$1,086	\$2,534	\$6,516	
	PS1	Data Collection and ITS Planning	\$0	\$35	\$35	\$0	\$450	\$450	

		Equipment Package	Expenditures for High Market Penetration	es tor nigr	ו ואומו הפו רמ	וופרומווסוו		
Yes         Yes         Yes         Average Annual Expenditure           Autromated rout signing         5.0         6.00         1.0         20           Autromated rout signing         2.0         5.0         5.0         5.0           Roodway processing Lanes         5.1,800         5.31         5.0         5.0           Roodway processing Lanes         5.1,800         5.31         5.0         5.0           Roodway processing Lanes         5.1,800         5.0         5.0         5.0           Roodway processing Lanes         5.1,800         5.0         5.1         5.0           Roodway Traffic information Dissemination         5.1,180         5.5         5.1         5.0           Roodway Traffic information Dissemination         5.1,180         5.0         5.1         5.0           Roodway Traffic information Dissemination         5.1,20         5.1         5.0         5.0           Roodway Dissemination         5.1,20         5.2         5.0         5.0         5.0           Roodway Dissemination         5.1,20         5.2         5.0         5.0         5.0         5.0           Roodway Dissemination         5.1         5.0         5.0         5.0         5.0         5.0			Non-Rect	urring Expen	ditures	Recurrin	ng Expenditu	ures
Equipment Package Name         1-5         6-10         11-20         5         10         20           Automated rank gigingly         Roadway Pollution and Environmental Hazards Indicators         \$2,000         \$3,110         \$5,30         \$5,12         \$5,00 <td< th=""><th></th><th></th><th>Yrs</th><th>Yrs</th><th>Yrs</th><th>Average Ar</th><th>nnual Expen</th><th>ditures</th></td<>			Yrs	Yrs	Yrs	Average Ar	nnual Expen	ditures
Readway Protect Beactrons   \$2,000   \$3,100   \$5,000   \$5,000   \$5,000   \$2,000		Equipment Package Name	1-5	6-10	11-20	5	10	20
Readway Publication Same Analysis (Section Processing	RS1	Automated road signing	\$0	\$0	\$0	\$0	\$0	\$0
Roadway Page Beacons         \$225         \$375         \$1,500         \$50         \$50           Roadway Page Beacons         \$1,800         \$50         \$1,000         \$50         \$50           Roadway Page Beacons         \$1,800         \$50         \$1,000         \$50         \$50           Roadway Spaters for AHS         \$1,000         \$50         \$51,000         \$50         \$50           Roadway Spate Page Include         \$1,320         \$1,170         \$54,60         \$60         \$810         \$51,00           Roadway Spate Currols         \$20,000         \$1,340         \$50         \$40         \$10         \$51,00         \$50         \$51         \$60         \$40         \$60         \$61,00	RS10	Roadway Pollution and Environmental Hazards Indicators	\$2,080	\$3,120	\$8,350	\$12	\$30	\$60
Roadway Sherine for three bears         \$180         \$50         \$100         \$50         \$50           Roadway Sherine for Arish for three for three for three shorts for Arish Sherine Sherine for Arish Sherine Sherine for Arish Sherine She	RS11	Roadway Probe Beacons	\$225	\$375	\$1,500	\$23	\$38	\$113
Roadway Systems for In AIS         \$ 1,00         \$ 0         \$ 1,00         \$ 0           Roadway Systems for In AIS         \$ 1,0812         \$ 0         \$ 1,00         \$ 0         \$ 1,00	RS12	Roadway Reversible Lanes	\$1,860	\$20	\$100	\$20	\$50	\$20
Roadway Talific Information Dissemination         \$10,812         \$6,656         \$12,640         \$419         \$419           Roadway Talific Information Dissemination         \$1,320         \$1,770         \$1,770         \$5,540         \$66         \$84           Roadway Fleeway Control         \$1,320         \$1,770         \$40,600         \$410         \$51         \$51           Roadway Placepare         \$23,040         \$45,600         \$40,600         \$51,00 </td <td>RS13</td> <td>Roadway Systems for AHS</td> <td>\$0</td> <td>\$0</td> <td>\$1,000</td> <td>\$0</td> <td>\$0</td> <td>\$100</td>	RS13	Roadway Systems for AHS	\$0	\$0	\$1,000	\$0	\$0	\$100
Roadsked styput Proutry         \$3.072         \$6.65         \$11.770         \$6.65         \$1.8177         \$6.65         \$6.81770         \$6.65         \$6.81770         \$6.65         \$6.81770         \$6.65         \$6.81770         \$6.65         \$6.81770         \$6.65         \$6.81770         \$6.65         \$6.81770         \$6.65         \$6.8170         \$6.65         \$6.8170         \$6.65         \$6.8170         \$6.65         \$6.8170         \$6.65         \$6.8170         \$6.65         \$6.8170         \$6.65         \$6.8170         \$6.65         \$6.8170 <td>RS14</td> <td>Roadway Traffic Information Dissemination</td> <td>\$10,812</td> <td>\$0</td> <td>\$0</td> <td>\$419</td> <td>\$419</td> <td>\$419</td>	RS14	Roadway Traffic Information Dissemination	\$10,812	\$0	\$0	\$419	\$419	\$419
Roadway Freeway Control         \$1,320         \$1,570         \$3,540         \$640         \$841         \$1,024	RS2	Roadside Signal Priority	\$3,072	\$6,656	\$18,176	\$26	\$64	\$109
Roadway yasas Cannelism         \$23,040         \$34,660         \$40,00         \$10,02	RS3	Roadway Freeway Control	\$1,320	\$1,770	\$3,540	\$66	\$88	\$89
Reactive Basic Surveillance   \$12,756   \$45,000   \$144,600   \$510   \$3510	RS4	Roadway Signal Controls	\$23,040	\$34,560	\$46,080	\$410	\$1,024	\$1,843
Read-way HOV Lisage	RS5	Roadway Basic Surveillance	\$22,750	\$45,000	\$134,600	\$910	\$3,510	\$10,166
Roadway In-Vehicle Signing         \$0         \$200         \$520         \$53         \$53           Readway In-Vehicle Signing         \$600         \$1,200         \$2,700         \$50         \$50           Readway Intersection Collision System         \$600         \$1,200         \$6,206         \$6,1255         \$6           Remote Interactive Information Reception         \$1,200         \$1,200         \$6,150         \$1,265         \$330         \$5           Remote Transit Executry UF         \$1,000         \$1,200         \$2,400         \$4,98         \$1,464         \$5           Remote Transit Executry UF         \$1,000         \$1,200         \$2,400         \$4,98         \$1,464         \$5           Remote Transit Executry UF         \$600         \$1,200         \$2,400         \$4,98         \$1,464         \$5           Remote Transit Executry UF         \$600         \$1,200         \$2,400         \$4,98         \$1,464         \$5           In Individual Condition         \$1,148         \$1,148         \$1,018         \$1,69         \$2,40         \$4,15         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$1,146         \$	RS6	Roadway HOV Usage	\$1,210	\$20	\$100	\$72	\$72	\$72
Roadway incident Detection         \$600         \$1,200         \$30         \$80           Roadway incident Detection         \$415         \$80.06         \$5.06         \$5.06         \$6.06         \$1.26         \$5.06         \$6.06         \$1.265	RS7	Roadway In-Vehicle Signing	\$0	\$200	\$525	\$0	\$13	\$25
Roadway Intersection Collision System         \$0         \$2,756         \$8,006         \$1,255         \$5           Remote Interactive Information Reception         \$15         \$630         \$4,156         \$628         \$1,255         \$5           Remote Transit Fare Management         \$1,000         \$1,325         \$9,700         \$165         \$330         \$5           Remote Transit Fare Management         \$1,000         \$1,226         \$9,700         \$165         \$330         \$5           Remote Transit Face Management         \$1,000         \$1,226         \$9,700         \$148         \$1,449         \$5           Remote Transit Security Reception         \$60         \$1,148 </td <td>RS8</td> <td>Roadway Incident Detection</td> <td>\$600</td> <td>\$1,200</td> <td>\$2,700</td> <td>\$30</td> <td>06\$</td> <td>\$180</td>	RS8	Roadway Incident Detection	\$600	\$1,200	\$2,700	\$30	06\$	\$180
Remote Interactive Information Reception         \$415         \$830         \$4,150         \$628         \$1,255         \$831           Remote Interactive Information Reception         \$1,000         \$1,925         \$9,700         \$165         \$330         \$8           Remote Transit Security VF         \$1,000         \$1,200         \$2,400         \$488         \$1,464         \$5           Remote Basic Information Reception         \$1,148         \$1,148         \$1,0328         \$208         \$415         \$5           Toll Plaza Toll Collection         \$315         \$60         \$1,648         \$144         \$1,464         \$5           Toll Plaza Toll Collection         \$1,448         \$1,148         \$1,032         \$2,08         \$415         \$49           Toll Plaza Toll Collection         \$315         \$36         \$36         \$50         \$183         \$203           TMC Indicent Departor Coordination Collection         \$315         \$264         \$634         \$183         \$275           TMC Protein Information Collection         \$1,441         \$1,434         \$434         \$434         \$434         \$443           TMC Prote Information Collection         \$1,434         \$2,434         \$434         \$434         \$4434         \$4434         \$4434	RS9	Roadway Intersection Collision System	\$0	\$2,756	\$8,006	\$0	\$0	\$0
Remote Mayday I/F         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$2	RTS1	Remote Interactive Information Reception	\$415	\$830	\$4,150	\$628	\$1,255	\$5,020
Remote Transit Fare Management         \$1,000         \$1,925         \$9,700         \$165         \$330           Remote Transit Fare Management         \$1,000         \$1,200         \$2,400         \$488         \$1,464           Remote Basic Information Reception         \$1,200         \$1,200         \$2,400         \$488         \$1,464           Toll Plaza Toll Collection         \$1,148         \$1,148         \$50.08         \$49         \$49         \$49           Toll Plaza Toll Collection         \$315         \$3,148         \$1,148         \$1,200         \$49         \$49         \$49           Toll Plaza Toll Collection         \$315         \$326         \$77         \$77         \$77         \$77           TMC Includ to In-Vehicle Signing         \$60         \$63         \$63         \$68         \$77         \$71         \$71         \$71         \$71         \$71         \$71         \$71         \$71         \$71         \$71         \$71         \$72         \$71	RTS2	Remote Mayday I/F	\$3	\$8	\$40	\$16	\$31	\$124
Remote Transit Security I/E         \$600         \$1,200         \$2,400         \$488         \$1,464           Remote Basic Information Reception         \$1,148         \$1,148         \$1,038         \$208         \$415           Toll Administration         \$56         \$70         \$168         \$77         \$77           Toll Plaza Toll Collection         \$315         \$50         \$168         \$77         \$77           Toll Collect Traffic Surveillance         \$735         \$368         \$735         \$136         \$203           TMC Incident Dispack Coordination Collection         \$21         \$264         \$183         \$275           TMC Individed Coordination         \$114         \$149         \$423         \$61         \$122           TMC Individed Coordination         \$114         \$148         \$423         \$61         \$122           TMC Individed Coordination         \$214         \$143         \$23         \$143         \$122           TMC Toll/Parking Coordination         \$233         \$163         \$143         \$143         \$143           TMC Toll/Parking Coordination         \$233         \$214         \$143         \$143         \$143           TMC Traffic Nework Performation Dissemination         \$233         \$143         \$	RTS3	Remote Transit Fare Management	\$1,000	\$1,925	\$9,700	\$165	\$330	\$1,320
Remote Basic Information Reception         \$1,148         \$10,328         \$208         \$415           Toll Administration         \$56         \$10         \$60         \$49         \$49           Toll Plaza Toll Collection         \$77         \$77         \$77         \$77           Collect Traffic Surveillance         \$735         \$386         \$77         \$77           Collect Traffic Surveillance         \$736         \$63         \$78         \$78           TMC Incident Dispatch Coordination         \$73         \$63         \$63         \$78           TMC Incident Dispatch Coordination         \$15         \$63         \$63         \$183         \$275           TMC Incident Dispatch Coordination         \$11         \$14         \$13         \$12         \$12           TMC Individual Condition         \$11         \$14         \$13         \$12         \$12           TMC Traffic Information Dissemination         \$23         \$18         \$443         \$1,491         \$23           TMC Traffic Network Performance Evaluation         \$23         \$2,117         \$4,434         \$497         \$1,491           TMC Advanced Stoad Management         \$23         \$2,117         \$4,434         \$491         \$491           TMC Fraffic Network	RTS4	Remote Transit Security I/F	\$600	\$1,200	\$2,400	\$488	\$1,464	\$1,952
Toll Administration         \$56         \$10         \$60         \$49         \$49           Toll Plaza Toll Collection         \$315         \$56         \$77         \$77         \$77           Toll Plaza Toll Collection         \$735         \$586         \$77         \$70         \$77           Toll Collect Traffic Surveillance         \$736         \$68         \$736         \$136         \$203           TMC Input to In-Vehicle Signing         \$0         \$63         \$64         \$183         \$276           TMC Input to In-Vehicle Signing         \$0         \$68         \$264         \$183         \$276           TMC Input to In-Vehicle Signing         \$217         \$148         \$243         \$280         \$419           TMC Input to In-Vehicle Signing         \$217         \$148         \$249         \$249         \$249           TMC Proble Information Dissemination         \$214         \$143         \$249         \$249         \$249           TMC Toll/Parking Coordination         \$221         \$24         \$144         \$229         \$249           TMC Traffic Network Performance Evaluation         \$287         \$2,117         \$4,434         \$497         \$1,491           TMC Advanced Signal Control         \$25         \$25 <td< td=""><td>RTS5</td><td>Remote Basic Information Reception</td><td>\$1,148</td><td>\$1,148</td><td>\$10,328</td><td>\$208</td><td>\$415</td><td>\$1,660</td></td<>	RTS5	Remote Basic Information Reception	\$1,148	\$1,148	\$10,328	\$208	\$415	\$1,660
Toll Plazar Toll Collection         \$315         \$168         \$77         \$77           Collect Traffic Surveillance         \$735         \$564         \$136         \$203           TMC Induct Lorderide Signing         \$9         \$264         \$634         \$183         \$275           TMC Induct or In-Vehicle Signing         \$0         \$66         \$673         \$678         \$678           TMC Induct or In-Vehicle Signing         \$217         \$109         \$217         \$280         \$418           TMC Induct or In-Vehicle Signing         \$217         \$109         \$217         \$280         \$418           TMC Probe Information Conditation         \$114         \$136         \$431         \$11         \$23           TMC Taffic Information Dissemination         \$223         \$163         \$431         \$149         \$140           TMC Taffic Information Dissemination         \$223         \$160         \$160         \$140         \$140           TMC Taffic Information Dissemination         \$233         \$160         \$140         \$140         \$140           TMC Taffic Maintenance Evaluation         \$823         \$160         \$160         \$160         \$160         \$160         \$160         \$160         \$160         \$160         \$160	TAS1	Toll Administration	\$26	\$10	\$60	\$49	\$49	\$49
Collect Traffic Surveillance         \$735         \$368         \$735         \$136         \$203           TMC Indicated Dispatch Coordination/Communication         \$399         \$264         \$183         \$275           TMC Induct on In-Vehicle Signing         \$0         \$63         \$0         \$68           TMC Chult-Model Coordination         \$121         \$181         \$217         \$280         \$419           TMC Probe Information Collection         \$114         \$181         \$423         \$61         \$121           TMC Traffic Information Dissemination         \$123         \$181         \$23         \$61         \$149           TMC Traffic Information Dissemination         \$233         \$163         \$23         \$23         \$23           TMC Traffic Network Performance Evaluation         \$233         \$163         \$149         \$230         \$149           TMC Traffic Network Performance Evaluation         \$233         \$163         \$140         \$230         \$140           TMC Avanced Signal Control         \$0         \$1,038         \$0         \$1,038         \$0         \$0           TMC Regional Traffic Control         \$364         \$1,038         \$1,038         \$0         \$0         \$0           TMC For Aks         TMC For Aks <td>TCS1</td> <td>Toll Plaza Toll Collection</td> <td>\$315</td> <td>\$0</td> <td>\$168</td> <td>\$77</td> <td>22\$</td> <td>22\$</td>	TCS1	Toll Plaza Toll Collection	\$315	\$0	\$168	\$77	22\$	22\$
TMC Incident Dispatch Coordination/Communication         \$399         \$264         \$63         \$183         \$275           TMC Incident Dispatch Coordination/Communication         \$217         \$199         \$217         \$68         \$419           TMC Input to In-Vehicle Signing         \$217         \$193         \$419         \$419         \$419           TMC Could mation Collection         \$114         \$136         \$423         \$61         \$122           TMC Tail/Parking Coordination         \$214         \$136         \$431         \$11         \$23           TMC Tail/Parking Coordination         \$233         \$166         \$431         \$1491         \$270           TMC Tail/In Information Dissemination         \$827         \$2,117         \$4,434         \$1497         \$1491           TMC Tail/In Information Dissemination         \$827         \$2,117         \$4,434         \$1,491         \$270           TMC Tail/In Information Dissemination         \$60         \$60         \$1,60         \$1,80         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1,491         \$1	TMS1	Collect Traffic Surveillance	\$735	\$368	\$735	\$136	\$203	\$339
TMC Input to In-Vehicle Signing         \$63         \$68         \$68           TMC Multi-Modal Coordination         \$217         \$109         \$217         \$280         \$419           TMC Multi-Modal Coordination         \$158         \$181         \$423         \$61         \$419           TMC Probe Information Collection         \$114         \$136         \$431         \$11         \$122           TMC Tailfic Information Dissemination         \$233         \$143         \$434         \$434         \$239         \$23           TMC Tailfic Information Dissemination         \$823         \$217         \$434         \$497         \$1,491         \$23           TMC Tailfic Network Performance Evaluation         \$60         \$60         \$160         \$1,434         \$249         \$270         \$	TMS10	TMC Incident Dispatch Coordination/Communication	\$399	\$264	\$634	\$183	\$275	\$458
TMC Multi-Modal Coordination         \$217         \$109         \$217         \$280         \$419           TMC Probe Information Collection         \$158         \$181         \$423         \$61         \$122           TMC Traffic Information Dissemination         \$134         \$136         \$136         \$139         \$23           TMC Traffic Information Dissemination         \$233         \$163         \$239         \$359         \$359           TMC Traffic Information Dissemination         \$233         \$163         \$239         \$359         \$359           TMC Traffic Information Dissemination         \$60         \$160         \$160         \$143         \$1491         \$1491           TMC Traffic Information Dissemination         \$60         \$60         \$160         \$180         \$239         \$239           TMC Traffic Information Dissemination         \$60         \$60         \$160         \$180         \$180         \$180           TMC Advanced Signal Control         \$60         \$16         \$160         \$160         \$160         \$160           TMC Basic Signal Control         \$60         \$16         \$160         \$160         \$160         \$160         \$160         \$160         \$160         \$160         \$160         \$160         \$160 </td <td>TMS11</td> <td>TMC Input to In-Vehicle Signing</td> <td>\$0</td> <td>\$63</td> <td>\$36</td> <td>\$0</td> <td>\$68</td> <td>\$68</td>	TMS11	TMC Input to In-Vehicle Signing	\$0	\$63	\$36	\$0	\$68	\$68
TMC Probe Information Collection         \$158         \$481         \$423         \$61         \$122           TMC Traffic Information Dissemination         \$233         \$136         \$431         \$11         \$23           TMC Traffic Information Dissemination         \$223         \$239         \$359         \$359           TMC Traffic Network Performance Evaluation         \$827         \$2,117         \$4,434         \$497         \$1,491           TMC Traffic Network Performance Evaluation         \$827         \$60         \$160         \$1,491         \$2,70           Traffic Maintenance         \$0         \$0         \$1,60         \$1,60         \$0         \$0         \$0           Distributed Road Management         \$0	TMS12	TMC Multi-Modal Coordination	\$217	\$109	\$217	\$280	\$419	669\$
TMC Toll/Parking Coordination         \$114         \$136         \$431         \$13         \$23         \$239         \$359           TMC Traffic Information Dissemination         \$233         \$163         \$371         \$239         \$359         \$359           TMC Traffic Network Performance Evaluation         \$40         \$60         \$160         \$1497         \$1491         \$14	TMS13	TMC Probe Information Collection	\$158	\$181	\$423	\$61	\$122	\$244
TMC Traffic Information Dissemination         \$233         \$163         \$359         \$359           TMC Traffic Network Performance Evaluation         \$827         \$2,117         \$4,434         \$497         \$1,491           Traffic Maintenance         \$40         \$60         \$160         \$180         \$270           Distributed Road Management         \$0         \$0         \$1,038         \$0         \$0           TMC Advanced Signal Control         \$354         \$364         \$1,811         \$205         \$409           TMC Regional Traffic Control         \$334         \$181         \$205         \$409         \$689           TMC Basic Signal Control         \$1,81         \$205         \$491         \$440         \$689           TMC Basic Signal Control         \$1,81         \$1,81         \$460         \$689         \$689         \$689           TMC Rosic Signal Control         \$1,81         \$1,81         \$1,81         \$1,81         \$1,81         \$1,81           TMC HOV/Reversible Lane Management         \$6         \$1,55         \$1,57         \$1,87         \$1,29         \$1,935           TMC Incident Detection         \$241         \$1,87         \$1,87         \$1,87         \$1,87         \$1,87           Fleet Maintena	TMS14	TMC Toll/Parking Coordination	\$114	\$136	\$431	\$11	\$23	\$57
TMC Traffic Network Performance Evaluation         \$827         \$2,117         \$4,434         \$497         \$1,491           Traffic Maintenance         \$40         \$60         \$160         \$180         \$270           Distributed Road Management         \$0         \$0         \$0         \$0         \$0           TMC Advanced Signal Control         \$0         \$1,038         \$0         \$0           TMC Advanced Signal Control         \$354         \$364         \$1,811         \$205         \$409           TMC Basic Signal Control         \$1,811         \$205         \$491         \$491         \$491           TMC Basic Signal Control         \$1,81         \$4,81         \$491         \$491         \$491           TMC FORMS         \$1,81         \$2,82         \$2,491         \$491         \$491           TMC HOV/Reversible Lane Management         \$604         \$727         \$1,529         \$1,290         \$1,935           TMC Incident Detection         \$241         \$121         \$6         \$1,290         \$1,935           Fleet Maintenance Management         \$241         \$121         \$1         \$2	TMS15	TMC Traffic Information Dissemination	\$233	\$163	\$371	\$239	\$329	\$598
Traffic Maintenance         \$40         \$60         \$160         \$180         \$270           Distributed Road Management         \$0         \$0         \$0         \$0         \$0           TMC Advanced Signal Control         \$0         \$1,038         \$0         \$0         \$0           TMC Basic Signal Control         \$354         \$364         \$1,811         \$205         \$409           TMC Basic Signal Control         \$1,561         \$460         \$689         \$689         \$689           TMC Basic Signal Control         \$0         \$1,561         \$460         \$69         \$60           TMC Basic Signal Control         \$0         \$0         \$0         \$271         \$60         \$60           TMC HOV/Reversible Lane Management         \$604         \$727         \$1,529         \$214         \$320           TMC Incident Detection         \$604         \$727         \$1,878         \$1,290         \$1,935           TMC Incident Detection         \$241         \$121         \$1         \$2	TMS16	TMC Traffic Network Performance Evaluation	\$827	\$2,117	\$4,434	\$497	\$1,491	\$2,485
Distributed Road Management         \$0 <t< td=""><td>TMS17</td><td>Traffic Maintenance</td><td>\$40</td><td>\$60</td><td>\$160</td><td>\$180</td><td>\$270</td><td>\$450</td></t<>	TMS17	Traffic Maintenance	\$40	\$60	\$160	\$180	\$270	\$450
TMC Advanced Signal Control         \$0         \$1,038         \$0         \$0           TMC Regional Traffic Control         \$364         \$364         \$1,811         \$205         \$409           TMC based Freeway Control         \$1391         \$1,561         \$460         \$689           TMC Basic Signal Control         \$1,561         \$460         \$491         \$491           TMC Basic Signal Control         \$0         \$0         \$271         \$0         \$0           TMC Control         \$1,561         \$2,71         \$0	TMS2	Distributed Road Management	\$0	\$0	\$0	\$0	\$0	\$0
TMC Regional Traffic Control         \$364         \$364         \$1,811         \$205         \$409           TMC based Freeway Control         \$146 <td< td=""><td>TMS3</td><td>TMC Advanced Signal Control</td><td>\$0</td><td>\$0</td><td>\$1,038</td><td>\$0</td><td>\$0</td><td>\$1,520</td></td<>	TMS3	TMC Advanced Signal Control	\$0	\$0	\$1,038	\$0	\$0	\$1,520
TMC based Freeway Control         \$391         \$586         \$1,561         \$460         \$689           TMC Basic Signal Control         \$196         \$195         \$195         \$491         \$491           TMC for AHS         \$0         \$271         \$0         \$0           TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320           TMC Incident Detection         \$604         \$727         \$1,878         \$1,935         \$1,935           Fleet Maintenance Management         \$241         \$129         \$12         \$22	TMS4	TMC Regional Traffic Control	\$364	\$364	\$1,811	\$205	\$409	\$1,023
TMC Basic Signal Control         \$196         \$195         \$491         \$491           TMC for AHS         \$0         \$271         \$0         \$0           TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320           TMC Incident Detection         \$604         \$727         \$1,878         \$1,935         \$1,935           Fleet Maintenance Management         \$241         \$121         \$22         \$22	TMS5	TMC based Freeway Control	\$391	\$586	\$1,561	\$460	\$689	\$1,149
TMC for AHS         \$0         \$271         \$0         \$0           TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320           TMC Incident Detection         \$604         \$727         \$1,878         \$1,290         \$1,935           Fleet Maintenance Management         \$241         \$121         \$0         \$14         \$22	TMS6	TMC Basic Signal Control	\$196	\$195	\$195	\$491	\$491	\$0
TMC HOV/Reversible Lane Management         \$462         \$332         \$1,529         \$214         \$320           TMC Incident Detection         \$604         \$727         \$1,878         \$1,290         \$1,935           Fleet Maintenance Management         \$241         \$121         \$0         \$14         \$22	TMS7	TMC for AHS	\$0	\$0	\$271	\$0	\$0	\$598
TMC Incident Detection         \$604         \$727         \$1,878         \$1,290         \$1,935           Fleet Maintenance Management         \$241         \$121         \$0         \$14         \$22	TMS8	TMC HOV/Reversible Lane Management	\$462	\$332	\$1,529	\$214	\$320	\$534
Fleet Maintenance Management         \$241         \$121         \$0         \$14         \$22	6SMT	TMC Incident Detection	\$604	\$727	\$1,878	\$1,290	\$1,935	\$3,225
	TRM1	Fleet Maintenance Management	\$241	\$121	\$0	\$14	\$22	\$22

FPM2         Transit Center Free and Load Management         Vrs         Transit Center Free and Load Management         S220         S230         S442         S504         S604           TRAM2         Transit Center Free and Load Management         S820         S220         S140         S0         S104         S0           TRAM3         Transit Center Free and Load Management         S220         S140         S6         S104         S0         S104         S0         S104         S0         S104         S0         S104         S0         S104         S104         S0         S104         S104         S0         S104         S104         S104         S0         S104			Non-Rect	Non-Recurring Expenditures	ditures	Recurri	Recurring Expenditures	ures	
Transit Center Rule: Moted Coordination   1-5   6-10   11-20   5-62			Yrs	Yrs	Yrs	Average A	nnual Expen	nditures	
Transit Control Free and Load Management	<u></u>	Equipment Package Name	1-5	6-10	11-20	2	10	20	
Transit Control Pixod-Route Operations \$497 \$5249 \$510 \$402 \$5104 \$11 and sticled refronce Multi-Model Condination \$280 \$5140 \$5140 \$20 \$5140 \$5104 \$11 and sticled and Departed Control Multi-Model Condination \$280 \$5140 \$5140 \$51735 \$510912 \$511,028 \$51,028 \$51,028 \$51,028 \$51,028 \$51,028 \$51,028 \$51,028 \$51,028 \$51,029 \$51,	M2	Transit Center Fare and Load Management	\$583	\$292	\$0	\$14	\$20	\$20	
Transit Center Paratransit Operations         \$63         \$15         \$104           Transit Center Paratransit Operations         \$280         \$280         \$21         \$	M3	Transit Center Fixed-Route Operations	\$497	\$249	\$0	\$462	\$694	\$694	
Transit Center Pearlerist I Operations   \$580   \$410   \$521   \$521   \$540   \$5614   \$521   \$540   \$5614   \$521   \$540   \$5614   \$561	M4	Transit Center Multi-Modal Coordination	\$0	\$353	\$15	\$0	\$104	\$104	
Transit Center Security   Sed   Se	M5	Transit Center Paratransit Operations	\$280	\$140	\$0	\$2	\$2	\$2	
Transit Center Tracking and Dispatch   \$847	M6	Transit Center Security	\$641	\$321	\$210	\$409	\$614	\$614	
On-board Maintenance         \$749         \$1,755         \$3,017         \$1,228         \$\$           On-board Maintenance         \$1,967         \$1,107         \$1,107         \$1,817         \$5,1861         \$5,1861         \$5,1687         \$5,1861         \$5,1861         \$5,1687         \$5,1861         \$5,1682         \$5,1687         \$5,1861         \$5,1687         \$5,1861         \$5,286         \$5,1684         \$5,268         \$5,1684         \$5,268	M7	Transit Center Tracking and Dispatch	\$847	\$1,694	\$45	\$267	\$802	\$802	
On-board Transit Diver If*         \$4,987         \$3,573         \$10,902         \$1,107         \$1,861         \$2,885         \$2,885         \$2,885         \$3,575         \$2,085         \$3,875         \$2,885         \$3,575         \$2,682         \$3,871         \$3,884         \$2,085         \$3,871         \$3,875 <td>7</td> <td>On-board Maintenance</td> <td>\$740</td> <td>\$1,735</td> <td>\$3,017</td> <td>\$367</td> <td>\$1,228</td> <td>\$1,497</td> <td></td>	7	On-board Maintenance	\$740	\$1,735	\$3,017	\$367	\$1,228	\$1,497	
On-board Transit Fare and Load Management         \$1,315         \$884         \$2,685         \$2,585         \$5,585 <t< td=""><td>V2</td><td>On-board Transit Driver I/F</td><td>\$4,987</td><td>\$3,573</td><td>\$10,902</td><td>\$1,107</td><td>\$1,851</td><td>\$2,257</td><td></td></t<>	V2	On-board Transit Driver I/F	\$4,987	\$3,573	\$10,902	\$1,107	\$1,851	\$2,257	
On-board Tensit Security         \$2,247         \$6,269         \$9,164         \$214         \$715           On-board Vehicle Signal Coordination         \$0         \$1,150         \$2,123         \$9         \$36           On-board Vehicle Signal Coordination         \$0         \$0         \$0         \$1466         \$2,453         \$5           On-board Tip Monitoring         \$0         \$1,150         \$1,150         \$1,466         \$2,453         \$5           Resis Vehicle Reception         \$10,666         \$2,81,33         \$249,909         \$0         \$0         \$0           Vehicle Lateral Control         \$0         \$13,579         \$12,690         \$1,60         \$3,888         \$5           Vehicle Lateral Control         \$0         \$1,3579         \$1,60<	٨3	On-board Transit Fare and Load Management	\$1,315	\$884	\$2,682	\$1,545	\$2,585	\$3,151	
On-board Vehicle Signal Coordination         \$0         \$1,150         \$2,123         \$0         \$130	۷4	On-board Transit Security	\$2,247	\$5,269	\$9,164	\$214	\$715	\$872	
Vehicle Dispatch Support         \$0         \$0         \$197         \$330           On-board Tip Monitoring         \$10,665         \$28,130         \$1,466         \$2,453         \$5           Basic Vehicle Lateral Control         \$0         \$10,665         \$28,130         \$1,466         \$2,453         \$5           Vehicle Lateral Control         \$0         \$119,622         \$0         \$119,622         \$0         \$0         \$5           Vehicle Lateral Control         \$0         \$13,579         \$126,603         \$0         \$388         \$5           Vehicle Longitudinal Control         \$0         \$13,579         \$126,603         \$0         \$388         \$5           Vehicle Longitudinal Control         \$0         \$13,579         \$14,629         \$1,880 <td>75</td> <td>On-board Vehicle Signal Coordination</td> <td>\$0</td> <td>\$1,150</td> <td>\$2,123</td> <td>\$0</td> <td>\$36</td> <td>29\$</td> <td></td>	75	On-board Vehicle Signal Coordination	\$0	\$1,150	\$2,123	\$0	\$36	29\$	
On-board Trip Monitoring         \$932         \$626         \$1,466         \$2,453         \$5           Basic Vehicle Reception         \$10,665         \$28,133         \$249,909         \$0         \$10,665         \$2,820         \$0         \$10,800         \$0         \$0         \$10,800         \$0	9/	Vehicle Dispatch Support	\$0	\$0	\$0	\$197	\$330	\$402	
Basic Vehicle Reception         \$10,665         \$28,133         \$249,909         \$0         \$0           Vehicle Lateral Varning System         \$0         \$13,579         \$12,679         \$126,603         \$0         \$388         \$5           Vehicle Lateral Varning System         \$0         \$13,579         \$52,63,830         \$0         \$388         \$5           Vehicle Longitudinal Control         \$0         \$50,577         \$419,299         \$18         \$3,880         \$5           Vehicle Mayday I/F         \$22,220         \$50,577         \$201,653         \$11,554         \$37,828         \$9           Vehicle Pre-Crash Safety Systems         \$0         \$1,271         \$41,274         \$60,444         \$60,44 <td>77</td> <td>On-board Trip Monitoring</td> <td>\$932</td> <td>\$626</td> <td>\$1,900</td> <td>\$1,466</td> <td>\$2,453</td> <td>\$2,990</td> <td></td>	77	On-board Trip Monitoring	\$932	\$626	\$1,900	\$1,466	\$2,453	\$2,990	
Vehicle Lateral Control         \$0         \$13,579         \$119,622         \$0         \$388         \$0         \$388         \$0         \$13,679         \$12,663         \$0         \$388         \$0         \$13,879         \$125,603         \$0         \$13,880         \$1,888	_	Basic Vehicle Reception	\$10,665	\$28,133	\$249,909	\$0	\$0	\$0	
Vehicle Lateral Warning System         \$0         \$13,579         \$125,603         \$0         \$388         \$3           Vehicle Longitudinal Control         \$622         \$135,171         \$419,299         \$18         \$388         \$1           Vehicle Longitudinal Varning System         \$22,220         \$50,527         \$201,653         \$11,554         \$3,880         \$1           Vehicle Pre-Crash Safety         \$14,221         \$50,527         \$201,653         \$11,554         \$30,880         \$2           Vehicle Pre-Crash Safety         \$14,221         \$94,414         \$588,406         \$6,044         \$46,170         \$2           Vehicle Pre-Crash Safety         Working Processers of AHS         \$0         \$20,244         \$91,631         \$30,260         \$71         \$7,760         \$2           Vehicle Processers of AHS         \$0         \$25,120         \$0         \$25,120         \$0	10	Vehicle Lateral Control	\$0	\$0	\$119,622	\$0	\$0	\$2,392	
Vehicle Longitudinal Control         \$6.820         \$5.820         \$53.830         \$1.8380         \$1.8	11	Vehicle Lateral Warning System	\$0	\$13,579	\$125,603	\$0	\$388	\$3,589	
Vehicle Longitudinal Warning System         \$622,220         \$135,171         \$419,299         \$18         \$3,880         \$1           Vehicle Mayday UF         \$22,220         \$50,527         \$201,653         \$11,554         \$37,828         \$9           Vehicle Pre-Crash Safety Systems         \$14,221         \$94,414         \$588,406         \$6,044         \$40,770         \$5           Vehicle Route Guidance         \$14,221         \$94,414         \$588,406         \$6,044         \$40,770         \$2           Vehicle Route Guidance         \$9,244         \$91,631         \$320,260         \$711         \$7,760         \$2           Vehicle Route Guidance         \$9,244         \$91,631         \$52,120         \$7         \$6         \$2           Vehicle Route Guidance         \$9,244         \$91,631         \$52,120         \$7         \$6<	12	Vehicle Longitudinal Control	\$0	\$5,820	\$53,830	\$0	\$388	\$3,589	
Vehicle Mayday UF         \$22,220         \$50,527         \$201,653         \$11,554         \$37,828         \$93           Vehicle Pre-Crash Safety Systems         \$0         \$131,584         \$0         \$14,670         \$0         \$1,671         \$0         \$0         \$24         \$0	13	Vehicle Longitudinal Warning System	\$622	\$135,171	\$419,299	\$18	\$3,880	\$11,962	
Vehicle Pre-Crash Safety Systems         \$0         \$131,584         \$0         \$1           Vehicle Route Guidance         \$14,221         \$94,414         \$588,406         \$6,044         \$46,170         \$24           Vehicle Route Guidance         \$9,244         \$91,631         \$320,260         \$711         \$7,760         \$24           Vehicle Systems for AHS         \$0         \$0         \$25,120         \$0         \$0         \$0           Vehicle Systems for AHS         \$0         \$2,133         \$5,627         \$49,982         \$0         \$0         \$0           Vehicle Toll/Parking I/F         \$0         \$41,708         \$257,187         \$0         \$0         \$1         \$24         \$25,10         \$2         \$25,10         \$2         \$25,10         \$2         \$25,10         \$2         \$25,10         \$2         \$25,10         \$2         \$25,10         \$2         \$25,20         \$2         \$25,20         \$2         \$25,20	14	Vehicle Mayday I/F	\$22,220	\$50,527	\$201,653	\$11,554	\$37,828	\$93,305	
Vehicle Route Guidance         \$14,221         \$94,414         \$588,406         \$6,044         \$46,170         \$24           Vehicle Safety Monitoring System         \$9,244         \$91,631         \$320,260         \$711         \$7,760         \$2           Vehicle Systems for AHS         \$0         \$22,120         \$0	15	Vehicle Pre-Crash Safety Systems	\$0	\$0	\$131,584	\$0	\$0	\$4,785	
Vehicle Safety Monitoring System         \$9,244         \$91,631         \$320,260         \$771         \$7,760         \$2.           Vehicle Systems for AHS         \$2,133         \$5,627         \$49,982         \$0 <t< td=""><td>16</td><td>Vehicle Route Guidance</td><td>\$14,221</td><td>\$94,414</td><td>\$588,406</td><td>\$6,044</td><td>\$46,170</td><td>\$244,029</td><td></td></t<>	16	Vehicle Route Guidance	\$14,221	\$94,414	\$588,406	\$6,044	\$46,170	\$244,029	
Vehicle Systems for AHS         \$0         \$0         \$25,120         \$0         \$0           Vehicle Toll/Parking I/F         \$2,133         \$5,627         \$49,982         \$0         \$0           Driver Safety Monitoring System         \$0         \$41,708         \$257,187         \$0         \$2,910         \$1           Driver Visibility Improvement System         \$0         \$140,097         \$143,546         \$0         \$0         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$2,910         \$1	17	Vehicle Safety Monitoring System	\$9,244	\$91,631	\$320,260	\$711	\$7,760	\$23,924	
9         Vehicle Toll/Parking I/F         \$2,133         \$5,627         \$49,982         \$0         \$0           Driver Safety Monitoring System         \$0         \$41,708         \$257,187         \$0         \$1,2910         \$1           Driver Visibility Improvement System         \$0         \$143,546         \$0         \$0         \$1         \$0         \$1         \$0         \$1         \$0         \$1 <td>18</td> <td>Vehicle Systems for AHS</td> <td>\$0</td> <td>\$0</td> <td>\$25,120</td> <td>\$0</td> <td>\$0</td> <td>\$718</td> <td></td>	18	Vehicle Systems for AHS	\$0	\$0	\$25,120	\$0	\$0	\$718	
Driver Safety Monitoring System         \$0         \$41,708         \$257,187         \$0         \$2,910         \$1           Driver Visibility Improvement System         \$0         \$143,546         \$0         \$0         \$1,622         \$1,607         \$0         \$1         \$0         \$1         \$0         \$1         \$0         \$1         \$1         \$1         \$1         \$1         \$1         \$2	19	Vehicle Toll/Parking I/F	\$2,133	\$5,627	\$49,982	\$0	\$0	\$0	
Driver Visibility Improvement System         \$0         \$143,546         \$0<	2	Driver Safety Monitoring System	\$0	\$41,708	\$257,187	\$0	\$2,910	\$17,943	
In-Vehicle Signing System         \$1,422         \$14,097         \$77,980         \$89         \$970         \$           Interactive Vehicle Reception         \$1,778         \$17,728         \$17,621         \$49,626         \$1,067         \$11,639         \$21           Probe Vehicle Software         \$356         \$1,584         \$6,337         \$71         \$388         \$21           Smart Probe         \$0         \$0         \$0         \$0         \$0         \$0           Vehicle Intersection Collision Warning         \$0         \$155         \$3,828         \$0         \$1           Vehicle Intersection Control         \$0         \$0         \$0         \$0         \$0	က	Driver Visibility Improvement System	\$0	\$0	\$143,546	\$0	\$0	\$7,177	
Interactive Vehicle Reception         \$1,778         \$17,621         \$49,626         \$1,067         \$11,639         \$20           Probe Vehicle Software         \$356         \$1,584         \$6,337         \$71         \$388         \$           Smart Probe         \$0         \$0         \$0         \$0         \$0         \$           Vehicle Intersection Collision Warning         \$0         \$155         \$3,828         \$0         \$19           Vehicle Intersection Control         \$0         \$0         \$0         \$0         \$0	4	In-Vehicle Signing System	\$1,422	\$14,097	\$77,980	\$88	\$970	\$4,785	
Probe Vehicle Software         \$356         \$1,584         \$6,337         \$71         \$388         \$           Smart Probe         \$0<	5	Interactive Vehicle Reception	\$1,778	\$17,621	\$49,626	\$1,067	\$11,639	\$28,709	
Smart Probe         \$0         \$0         \$0         \$0         \$0           Vehicle Intersection Control         \$0         \$155         \$3,828         \$0         \$19           Vehicle Intersection Control         \$0         \$0         \$0         \$0         \$0	9	Probe Vehicle Software	\$356	\$1,584	\$6,337	\$71	\$388	\$1,196	
Vehicle Intersection Control         \$0         \$155         \$3,828         \$0         \$19           Vehicle Intersection Control         \$0         \$0,570         \$0         \$0	7	Smart Probe	\$0	\$0	\$0	\$0	\$0	\$0	
Vehicle Intersection Control         \$0         \$0         \$0         \$0	8	Vehicle Intersection Collision Warning	\$0	\$155	\$3,828	\$0	\$19	\$478	
	6	Vehicle Intersection Control	\$0	\$0	\$9,570	\$0	\$0	\$478	

	Equipment Package Expenditures for High Market Penetration	penditure	s for Hig	h Market	Penetratic	uc	
Gov	Government Stakeholder	Non-Recu	Non-Recurring Expenditures	ditures	Recurr	Recurring Expenditures	tures
		Yrs	Yrs	Yrs	Average A	Average Annual Expenditures	nditures
Subsystem	Subsystem Name	1-5	6-10	11-20	2	10	20
CVAS	Commmercial Vehicle Administration Subsystem	\$379	\$1	\$16	\$494	\$494	\$494
CVCS	Commercial Vehicle Check Subsystem	\$326	\$0	\$80	6\$	6\$	6\$
EMS	Emergency Management Subsystem	\$406	\$309	\$792	\$295	\$444	\$589
EMMS	Environmental And Emmisions Management Subsystem	\$1	\$0	\$0	\$107	\$107	\$107
EVS	Emergency Vehicle Subsystem	\$1,867	\$4,855	\$12,560	\$356	\$1,280	\$2,392
PMS	Parking Management Subsystem	\$645	\$920	\$3,625	\$1,086	\$2,534	\$6,516
PS	Planning Subsystem	\$0	\$35	\$35	\$0	\$450	\$450
RS	Roadside Subsystem	\$66,969	\$95,737	\$224,677	\$2,017	\$5,397	\$13,225
RTS	Remote Traveler Subsystem	\$1,600	\$3,125	\$12,100	\$653	\$1,794	\$3,272
TAS	Toll Administration Subsystem	\$26	\$10	09\$	\$49	\$49	\$49
TCS	Toll Collection Subsystem	\$315	\$0	\$168	\$77	\$77	\$77
TMS	Traffic Management Subsystem	\$4,738	\$5,662	\$15,721	\$4,246	\$7,075	\$13,446
TRMS	Transit Management Subsystem	\$3,089	\$3,168	\$270	\$1,168	\$2,258	\$2,258
TRVS	Transit Vehicle Subsystem	\$10,220	\$13,236	\$29,788	\$4,897	\$9,198	\$11,238

Expenditures are in constant 1995 dollars in (1,000's) \$299,892 \$15,452 \$31,165 \$54,121 \$127,057 \$90,609

FIGURE 5.3-3 URBANSVILLE SUMMARY GOVERNMENT ONLY EXPENDITURES FOR HIGH MARKET PENETRATION

### 6. SAMPLE EXPENDITURE CALCULATIONS - INTER-URBAN AREA

The Phase II cost evaluation of the National ITS Architecture includes an evaluation of three separate scenarios. Each scenario represents a typical deployment area and is to provide a frame of reference for similar implementations of the architecture. A high level description of the inter-urban area, Thruville, is included in the Evaluatory Design Document. A more in-depth description of Thruville is located in the "Inter-Urban Scenario Guide, Thruville, Phase II" scenario description document. The scenario description is a common description utilized for numerous architecture evaluation activities, including: the cost evaluation, the benefit analysis, as well as technical performance analyses. Thus, the results of the various architecture evaluation activities are all based upon one common set of assumptions.

The cost analysis evaluates five, ten and twenty year deployment milestones.

### **6.1** Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the previous sections 4.6.1 through 4.6.19. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and maintenance requirements. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology (often referenced to equipment manufacturers' estimated unit prices for comparable technology and referenced to integration and systems engineering companies' and equipment manufacturers' estimated unit prices for comparable technology.)

The unit price justification is noted in the Common Equipment section of 4.6 and in the worksheets' column for "Comparative Technology." In the worksheets, where "Existing Technology" is noted, the prices represent typical unit prices for equipment found in catalogs, such as Sweet's Engineering and Retrofit, a catalog for construction cost estimating for current, off-the-shelf technology. Other references to price justification indicate specific construction bid prices for recent contracts. These prices are actual bid prices for installation. Where these two forms of justification were not available, some estimations are provided through consultations with experts in respective fields for manufacturing, and system integration. Lastly, some prices which are less certain are estimates based on professional judgement.

### 6.2 Identification and Evaluation of Quantities and Market Size

For the Equipment Package parameters, the quantity of items purchased influences the unit price for the equipment. Obviously, price breaks come into effect when larger quantities are purchased. For existing technology, many equipment prices are at a steady state price (exhibited in the far right columns of the Equipment Worksheets.) The prices are generally not subject to wide fluctuations based on quantities. Newer technology, or services which are on the front end of a market/product development curve, are subject to wide price ranges.

For Thruville, two sets of market penetrations were analyzed, a high and a low scenario. For the cost evaluation activities the low value of the unit price ranges was utilized for all Equipment Packages.

### **6.3** Calculation of Expenditures

Expenditures are calculated automatically through the linked spreadsheet programs. Included in the calculation are non-recurring expenditures (one-time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred in accordance with the Evaluatory Design Document deployment quantities for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the expenditures for asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets. This tabulation of non-recurring expenditures continues from the year of initial deployment through the analysis time frame. This evaluation is important when considering comparative technologies and life cycle costs (see previous section on life cycle costing.)

### 6.4 Results

Similar to the results from the Urbansville analysis, tabulated below are the non-recurring and recurring expenditures for a minimal basic service a mid-range service, and a comprehensive service, that would be experienced by one individual in the individual consumers group. As stated in section 4.6.19, the unit price of equipment for in-vehicle devices are based on existing technology, or nationally developed technology which takes advantage of national market deployment price breaks.

Basic service provides the capability for drivers to interface with the ISP Subsystem's Basic Information Broadcast Equipment Package, receive formatted traffic advisories including accurate traveling information concerning available travel options, their availability, and congestion information in their vehicle. Basic Service also provides Vehicle MAYDAY service. Mid-range Service provides the Basic services plus In-Vehicle hardware, and software for Vehicle Route Guidance and Interactive Vehicle Reception. The comprehensive Service provides the Basic and Mid-range Services plus equipment for In-Vehicle Signing, Probe Vehicle Software, Smart Probe, and Vehicle Route Guidance.

### INDIVIDUAL NON-RECURRING EXPENDITURES

Basic Service	VS1, VS14	\$450
Mid-range Service	Basic+VS5,VS16	\$1,350
Comprehensive Service	Mid-Range+VS4,VS6,VS7, VS19	\$2,140

If all vehicle Equipment Packages including safety systems are combined, the total per vehicle non-recurring expenditure is \$8,310.

### INDIVIDUAL MONTHLY RECURRING EXPENDITURES

	Ope	eration	Maintenance
Basic Service	VS1, VS14	\$10	\$1
Mid-range Service	Basic+VS5,V16	\$35	<\$5
Comprehensive Service	Mid-Range+VS4,VS6,VS7, VS19	\$35	<\$8

The monthly service charges for in-vehicle services are in the range of \$0 to \$43 per month for individual users (based on average usage) and are comparable to current service cost experiences for cellular telephone service.

Scenario expenditures for Mountainville are classified into likely stakeholder responsibility for funding. The resulting allocations are presented below.

### Thruville High Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	13%
Commercial	5%
Individual	82%

### Thruville Low Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	27%
Commercial	6%
Individual	67%

The summary expenditures for the Thruville Equipment Packages are provided in the following pages. The non-recurring expenditures are tabulated below for the deployment milestone in the evaluation period. Note that the summations consists of the expenditures for the year stated plus the expenditures for the four previous years. The numbers presented for the recurring expenditures represent the expenditures for operation and maintenance during the deployment milestone years. Note that the non-recurring expenditures include replacement expenditures for reinvestment of equipment at the end of its' useful life.

The first of the analysis results, are for a low level market penetration, consistent with the evaluatory design parameters for deployment penetration. The second set of results are for the high level market penetration. The last results page is reflective of the government expenditures.

EP ID         Equipment Package Name         Vrs. vrs. vrs. vrs. vrs. vrs. vrs. vrs. v		_							
Visa         Yrs         Yrs         Average Annual Expenditus           Condentials and Taxes Administration         \$553         Yrs         556         10         2           Condentials and Taxes Administration         \$553         \$5         \$5         \$10         \$10           Condentials and Taxes Administration         \$50         \$6         \$0         \$10         \$			Non-Recu	ırring Exper	ditures	Recurri	ng Expenditι	rres	
DD         Equipment Package Name         1-5         6-10         11-20         5         10         25/2         5/10         10         25/2         5/10         10         25/2         5/10         10         25/2         5/10         10         25/2         5/10			Yrs	Yrs	Yrs	Average A	nnual Expen	ditures	
Condentials and Taxes Administration         \$55.3         \$1         \$20         \$56.2         \$56.2           CV Stafety Administration         \$20         \$50		Equipment Package Name	1-5	6-10	11-20	2	10	20	
CV Information Exchange         \$4.3         \$0         \$15.4         \$15.6           CV Information Exchange         \$8.0         \$0         \$0         \$5.0         \$0         \$0           CV Information Exchange         \$40         \$0         \$0         \$0         \$0         \$0         \$0           Informational Excitor (Crossing)         \$0	CVA1	Credentials and Taxes Administration	\$553	\$1	\$32	\$562	\$562	\$562	
International Data Manuscriation   \$60   \$60   \$70   \$80	CVA2	CV Information Exchange	\$43	\$0	\$0	\$154	\$154	\$154	
Charton and Accident Recording \$40 \$50 \$50 \$50 \$50 \$50 \$50 \$50 \$50 \$50 \$5	CVA3	CV Safety Administration	\$80	\$0	\$0	\$0	\$0	\$0	
Contraction and Auctioning Readerier Electronic Reacording         \$40         \$50         \$50         \$53           Readsider Electronic Reacording         \$641         \$60         \$160         \$17         \$17           Readsider Electronic Streening         \$681         \$60         \$160         \$17         \$17           Readsider Electronic Streening         \$68         \$68         \$30         \$50         \$57           Readsider Electronic Data         \$18         \$170         \$103         \$20         \$51           On-board Cargo Monitoring         \$18         \$170         \$103         \$51         \$55           On-board VS electronic Data         \$11,43         \$4,855         \$231,29         \$174         \$175           On-board VS electronic Data         \$1,43         \$4,855         \$231,29         \$174         \$175           On-board View Montoring         \$1         \$1,43         \$4,855         \$231,29         \$17         \$175           Emergency National Cardin Management Communication         \$0         \$16         \$21         \$17         \$15           Cho-board View Page and Electronic Signal Coordination Control Signal Coordination Communication         \$20         \$21         \$15           Cho-board View Page and Electronic Signal	CVA4	International CV Administration	\$0	\$0	\$0	\$0	\$0	\$0	
Readside Selectric Cocesting	CVC1	Citation and Accident Electronic Recording	\$40	\$0	\$0	\$3	\$3	\$3	
Readside Electront Screening         \$651         \$67         \$17         \$17           Readside Salety Inspection         \$30         \$68         \$12         \$55           On-board Cargo Monitoring         \$10         \$30         \$30         \$50         \$57           On-board Cargo Monitoring         \$11         \$1038         \$56         \$55         \$55           On-board Cargo Monitoring         \$1,143         \$4,885         \$31,29         \$14         \$55           On-board CV Salety         \$1,000         \$1	CVC2	International Border Crossing	\$0	\$0	\$0	\$0	\$0	\$0	
Roadside Saley inspection         \$88         \$6         \$12         \$5           Roadside Saley inspection         \$90         \$50         \$30         \$12           On-board Cargy Monitoring         \$18         \$170         \$1038         \$55         \$22           On-board CV Salety         \$143         \$4,855         \$31,29         \$144         \$75           On-board CV Salety         \$1,143         \$4,855         \$31,29         \$144         \$75           Choboard CV Salety         \$1,143         \$4,855         \$31,29         \$144         \$75           Choboard CV Salety         \$1,143         \$4,855         \$31,129         \$14         \$75           Choboard Tipp Monitoring         \$0         \$11,6         \$10         \$10         \$10           Choboard Tipp Monitoring         \$0         \$11,6         \$11         \$10         \$10         \$10           Choboard Tipp Monitoring         \$0         \$11,6         \$1,1         \$10	CVC3	Roadside Electronic Screening	\$651	\$0	\$160	\$17	\$17	\$17	
Readslife WIM         \$30         \$50         \$20         \$20           On-board Cago Montoring         \$18         \$170         \$1,038         \$2         \$178           On-board CV Safeky         \$18         \$170         \$1,038         \$5         \$178           On-board CV Safeky         \$1,143         \$4,143         \$4,143         \$1,78           On-board Tip Montoring         \$1,143         \$4,145         \$1,44         \$773           Emergency And Indean Management Communications         \$0         \$1         \$1         \$1           Emergency Mackay and E-911 Inf         \$0         \$1         \$2         \$1         \$1           Emergency Mackay and E-91 Inf         \$0         \$1         \$1         \$1         \$1           Emergency Mackay and E-91 Inf         \$0         \$1         \$1         \$1         \$1           Chrobard EV Incident Management         \$20         \$1         \$2         \$1         \$1         \$1           On-board Vehicle Signal Coordination         \$20         \$21         \$2         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1	CVC4	Roadside Safety Inspection	\$88	9\$	\$12	\$5	\$2	\$5	
On-board Cargo Monitoring         \$6         \$300         \$78           On-board C Velectronic Data         \$1         \$10         \$1038         \$5         \$55           On-board C V Electronic Data         \$1         \$1         \$1         \$56         \$1         \$56           On-board C V Electronic Data         \$1         \$1         \$1         \$56         \$1         \$1         \$56           Chenged C V Incleant Management Communication         \$0         \$10         \$2         \$1	CVC5	Roadside WIM	\$30	\$0	\$30	\$2	\$2	\$2	
On-board CV Electronic Data         \$18         \$170         \$1038         \$55           On-board CV Salety         \$134         \$144         \$15           On-board Tip Monitoring         \$1,143         \$48,65         \$31,129         \$144         \$75           Emergency and Incident Management Communications         \$0         \$105         \$21         \$144         \$75           Emergency and Incident Management Communications         \$0         \$10         \$21         \$10         \$2           Emergency Vehicle Routing and communications         \$0         \$11         \$181         \$0         \$15           Emergency Vehicle Routing and communications         \$0         \$1         \$181         \$0         \$16           Emergency Vehicle Routing and Communication         \$245         \$624         \$243         \$24         \$16           Christone and All All All All All All All All All Al	CVS1	On-board Cargo Monitoring	\$0	\$68	\$300	\$0	\$178	\$786	
Chroband CV/ Selety	CVS2	On-board CV Electronic Data	\$18	\$170	\$1,038	\$5	\$55	\$303	
Con-board Trip Monitoring	CVS3	On-board CV Safety	\$39	\$164	\$895	\$1	\$6	\$26	
Emergency and Incident Management Communication         \$0         \$6         \$7         \$7           Emergency Mandagement Communications         \$0         \$105         \$71         \$0         \$71           Emergency Nackage and Environmental Data Management         \$0         \$11         \$181         \$0         \$15           Emergency Verkide Routing and communications         \$0         \$1         \$181         \$0         \$10           Emergency Verkide Routing and communication         \$205         \$1         \$2         \$0         \$10           On-board Verkide Routing and Environmental Data Management and Reporting         \$205         \$573         \$243         \$45         \$145           On-board Verkide Signal Coordination         \$205         \$571         \$74         \$45         \$16           Fleet Administration         Fleet Administration         \$24         \$574         \$54         \$16           Fleet HAZMAT Management         \$2         \$24         \$51         \$2         \$1           Fleet HAZMAT Management         \$1         \$2         \$2         \$2         \$1           Fleet HAZMAT Management         \$1         \$2         \$2         \$2         \$1         \$1         \$1           Fleet Maintenance Manag	CVS4	On-board Trip Monitoring	\$1,143	\$4,855	\$33,129	\$144	\$753	\$4,160	
Emergency Mayday and E-911 UF         \$0         \$105         \$21         \$2           Emergency Response Management         \$0         \$11         \$0         \$136           Emergency Vehicle Rouning and communications         \$0         \$1         \$0         \$107           Emissions and Environmental Data Management         \$225         \$524         \$50         \$107           On-board EV Incident Management Communication         \$226         \$524         \$2,946         \$40         \$107           On-board Vehicle Signal Coordination         \$226         \$524         \$524         \$40         \$145           On-board Vehicle Signal Coordination         \$356         \$713         \$744         \$54         \$161           Fleet Administration         \$136         \$52         \$54         \$102         \$161           Fleet HAZMAT Management         \$2         \$4         \$10         \$1         \$24           Fleet HAZMAT Management         \$12         \$24         \$10         \$1         \$1         \$24           Fleet HAZMAT Management         \$12         \$24         \$10         \$1         \$1         \$2           Fleet Maninearion Broadcast         \$12         \$24         \$1         \$1         \$2         <	EM1	Emergency and Incident Management Communication	\$0	9\$	2\$	\$0	2\$	\$15	
Emergency Response Management         \$0         \$14         \$18         \$0         \$136           Emergency Verbicle Routing and communications         \$0         \$1         \$2         \$0         \$11           Ch-board Vehicle Routing and communication         \$245         \$635         \$2,946         \$40         \$145           On-board Vehicle Signal Coordination         \$202         \$524         \$2,434         \$45         \$161           Fleet Administration         \$356         \$713         \$574         \$73         \$161           Fleet Administration         \$356         \$71         \$734         \$45         \$16           Fleet Hamiltonation Broadcast         \$0         \$27         \$5         \$0         \$1           Fleet Maintenance Management         \$1         \$24         \$1         \$1         \$1	EM2	Emergency Mayday and E-911 I/F	\$0	\$105	\$210	\$0	\$2	\$5	
Emergency Vehicle Routing and communications         \$0         \$1         \$0         \$1           Emissions and Environmental Data Management         \$24         \$635         \$2,946         \$0         \$107           On-board Vehicle Routing Management Communication         \$202         \$524         \$2,946         \$445         \$145           On-board Vehicle Signal Coordination         \$202         \$524         \$2,946         \$46         \$16           Fleet HAZMA Management         \$311         \$537         \$714         \$54         \$16           Fleet HAZMA Management         \$5         \$4         \$14         \$1         \$1           Fleet Mainistration and Management         \$121         \$241         \$241         \$5         \$1           Fleet Mainistration and Management         \$121         \$241         \$241         \$1         \$1         \$1           Fleet Mainistration and Management         \$1         \$242         \$1         \$2         <	EM3	Emergency Response Management	\$0	\$91	\$181	\$0	\$136	\$273	
Emissions and Environmental Data Management         \$0         \$10         \$10           On-board EV Incident Management Communication         \$245         \$655         \$2,946         \$40         \$145           For Dovard EV Incident Management Communication         \$252         \$524         \$45         \$161           Feet Administration         Freight Coordination         \$31         \$713         \$734         \$5         \$1026           Feet HAZMAT Management         \$31         \$637         \$714         \$342         \$1,026         \$1           Freight Administration and Management         \$31         \$637         \$714         \$342         \$1,026         \$1           Freight Administration and Management         \$12         \$24         \$1         \$24         \$1,026         \$1           Freight Administration and Management         \$12         \$24         \$1         \$24         \$1         \$	EM4	Emergency Vehicle Routing and communications	\$0	\$1	\$2	\$0	\$1	\$2	
On-board EV Incident Management Communication         \$245         \$635         \$2,946         \$40         \$145           On-board Vehicle Signal Coordination         \$202         \$524         \$2,34         \$45         \$161           Fleet Administration         \$356         \$713         \$574         \$545         \$16           Fleet HAZNAT Management         \$0         \$27         \$67         \$1         \$1           Freight Administration and Management         \$1         \$27         \$63         \$1         \$4           Freight Administration and Management         \$121         \$241         \$24         \$1         \$4           Freight Administration and Management         \$121         \$24         \$1         \$1         \$4           Freight Administration and Management         \$121         \$24         \$1         \$1         \$4           Freight Administration and Management         \$1         \$24         \$1         \$1         \$2           Free Maintenance Management         \$1         \$24         \$24         \$1         \$1         \$2           Basic Information Bioaccast         \$1         \$2         \$24         \$1         \$1         \$1           Infrastructure Provided Dynamic Researcation         \$0	EMM1	Emissions and Environmental Data Management	\$0	\$1	\$0	\$0	\$107	\$107	
Peter Administration   \$202	EVS1	On-board EV Incident Management Communication	\$245	\$635	\$2,946	\$40	\$145	\$487	
Fleet Administration   \$356   \$713   \$734   \$5 \$16     Fleet Credentials and Taxes Management and Reporting   \$311   \$637   \$714   \$342   \$1,026     Fleet HAZMAT Management   \$9   \$27   \$5   \$9   \$1     Fleet HAZMAT Management   \$121   \$241   \$7   \$7   \$24     Fleet Hazmation and Management   \$121   \$241   \$7   \$7   \$24     Fleet Information Broadcast   \$122   \$493   \$1,156   \$316   \$531     Eastic Information Dissemination   \$0   \$0   \$0   \$0   \$1     East Internation Provided Dynamic Ridesharing   \$0   \$0   \$0   \$0     Infrastructure Provided Dynamic Ridesharing   \$0   \$0   \$0   \$0     Infrastructure Provided Name Selection   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Information Reception   \$0   \$0   \$0   \$0     Infrastructure Information Reception   \$0   \$0   \$0   \$0     Infrastructure Information Reception   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0   \$0     Is Probe Information Reception   \$0   \$0   \$0   \$0     Is Probe Information Reception   \$0   \$0   \$0   \$0     Infrastructure Provided Name Pages & Reservation   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0     Infrastructure Provided Vallow Pages & Reservation   \$0   \$0   \$0	EVS2	On-board Vehicle Signal Coordination	\$202	\$524	\$2,434	\$45	\$161	\$538	
Fleet Credentials and Taxes Management and Reporting         \$311         \$637         \$714         \$342         \$1,026           Fleet HAZMAT Management         \$0         \$27         \$5         \$0         \$1           Freight Administration and Management         \$2         \$4         \$1         \$24         \$1           Fleet Maintenance Management         \$1         \$241         \$241         \$24         \$2           Fleet Maintenance Management         \$1         \$241         \$241         \$1         \$2           Fleet Maintenance Management         \$0         \$0         \$0         \$249         \$1,156         \$24         \$2           EM Route Information Broadcast         \$0	FMS1	Fleet Administration	\$356	\$713	\$734	\$5	\$16	\$26	
Freight Administration and Management         \$0         \$27         \$5         \$0         \$1	FMS2		\$311	\$637	\$714	\$342	\$1,026	\$1,711	
Freight Administration and Management         \$1         \$4         \$10         \$1         \$4           Fleet Maintenance Management         \$121         \$241         \$7         \$22           Basic Information Broadcast         \$422         \$493         \$1,156         \$316         \$631           EM Route Plan Information Dissemination         \$0         \$0         \$254         \$0         \$0           Infrastructure Provided Dynamic Ridesharing         \$0         \$106         \$13         \$0         \$13           Infrastructure Provided Dynamic Ridesharing         \$0         \$10         \$10         \$13         \$13         \$13           Infrastructure Provided Power Selection         \$0         \$10         \$10         \$13	FMS3		0\$	\$27	\$5	\$0	\$1	\$1	
Fleet Maintenance Management         \$121         \$241         \$24         \$22           Basic Information Broadcast         \$422         \$493         \$1,156         \$316         \$631           EM Route Plan Information Dissemination         \$0         \$0         \$0         \$0         \$0           Infrastructure Provided Dynamic Ridesharing         \$0         \$106         \$0         \$0         \$0           Infrastructure Provided Pollow Pages & Reservation         \$0         \$1,550         \$0         \$13           Infrastructure Provided Yellow Pages & Reservation         \$0         \$712         \$733         \$0         \$0           Infrastructure Provided Yellow Pages & Reservation         \$0         \$712         \$733         \$0         \$0           Infrastructure Provided Yellow Pages & Reservation         \$0	FMS4	Freight Administration and Management	\$2	\$4	\$10	\$1	\$4	\$6	
Basic Information Broadcast         \$422         \$493         \$1,156         \$316         \$631           EM Route Plan Information Dissemination         \$0         \$0         \$254         \$0         \$0           Infrastructure Provided Dynamic Ridesharing         \$0         \$350         \$106         \$0         \$13           Infrastructure Provided Route Selection         \$0         \$712         \$733         \$0         \$13           Infrastructure Provided Route Selection         \$0         \$712         \$772         \$733         \$0         \$236           Infrastructure Provided Route Selection         \$0         \$712         \$773         \$0 <t< td=""><td>FMS5</td><td>Fleet Maintenance Management</td><td>\$121</td><td>\$241</td><td>\$241</td><td>\$2</td><td>\$22</td><td>\$36</td><td></td></t<>	FMS5	Fleet Maintenance Management	\$121	\$241	\$241	\$2	\$22	\$36	
EM Route Plan Information Dissemination         \$0         \$0         \$254         \$0         \$0           Infrastructure Provided Dynamic Ridesharing         \$0         \$350         \$1,550         \$0         \$13           Infrastructure Provided Route Selection         \$0         \$712         \$733         \$0         \$13           Infrastructure Provided Route Selection         \$0         \$712         \$733         \$0         \$13           Infrastructure Provided Yellow Pages & Reservation         \$0         \$712         \$734         \$1         \$235           Intractive Infrastructure Information         \$0         \$0         \$0         \$0         \$0         \$0           ISP Probe Information Reception         \$0	ISP1	Basic Information Broadcast	\$422	\$493	\$1,156	\$316	\$631	\$1,262	
Infrastructure Provided Dynamic Ridesharing         \$0         \$106         \$106         \$0         \$10           Infrastructure Provided Route Selection         \$0         \$350         \$1,550         \$0         \$13           Infrastructure Provided Yellow Pages & Reservation         \$0         \$712         \$733         \$0         \$136           Interactive Infrastructure Information         \$0         \$359         \$378         \$794         \$118         \$235           IsP Advanced Integrated Control Support         \$0	ISP2	EM Route Plan Information Dissemination	0\$	\$0	\$254	\$0	\$0	\$11	
Infrastructure Provided Route Selection         \$0         \$350         \$1,550         \$0         \$13           Infrastructure Provided Yellow Pages & Reservation         \$0         \$712         \$733         \$0         \$236           Interactive Infrastructure Information         \$0         \$378         \$794         \$118         \$235           ISP Advanced Integrated Control Support         \$0         \$0         \$0         \$0         \$0           ISP Probe Information Collection         \$0         \$0         \$0         \$0         \$0           ISP Probe Information Reception         \$1         \$1,813         \$2         \$138           Personal Basic Information Reception         \$1         \$1,813         \$2         \$138           Personal Interactive Information Reception         \$1         \$1,304         \$1         \$1           Personal Mayday I/F         \$1         \$1,304         \$1         \$1           Personal Reception         \$1         \$1,304         \$1         \$1           Personal Mayday I/F         \$1         \$1         \$1         \$1           Personal Reception         \$1         \$1         \$1         \$1           Personal Mayday I/F         \$1         \$1         \$1	ISP3	Infrastructure Provided Dynamic Ridesharing	\$0	\$0	\$106	\$0	\$0	\$156	
Infrastructure Provided Yellow Pages & Reservation         \$0         \$712         \$734         \$18         \$235           Interactive Infrastructure Information         \$0         \$378         \$794         \$118         \$235           IsP Advanced Integrated Control Support         \$0         \$0         \$0         \$0         \$0           IsP Probe Information Collection         \$0         \$0         \$0         \$0         \$0           Personal Basic Information Reception         \$1         \$1,813         \$2         \$138           Personal Interactive Information Reception         \$1         \$1,304         \$7         \$2           Personal Mayday I/F         \$1,304         \$1         \$1,004           Personal Route Guidance         \$118         \$1,304         \$1,004           Personal Route Guidance         \$118         \$1,57         \$1,58         \$2,385           Parking Management         \$6         \$35         \$109         \$36           Data Collection and ITS Planning         \$0         \$35         \$2         \$45	ISP4	Infrastructure Provided Route Selection	\$0	\$350	\$1,550	\$0	\$13	\$20	
Interactive Infrastructure Information	ISP5	Infrastructure Provided Yellow Pages & Reservation	\$0	\$712	\$733	\$0	\$236	\$473	
ISP Advanced Integrated Control Support         \$0         \$0         \$0         \$0           ISP Probe Information Collection         \$0         \$0         \$250         \$0         \$0           Personal Basic Information Reception         \$10         \$10         \$136         \$138         \$138           Personal Interactive Information Reception         \$10         \$10         \$10         \$10         \$10           Personal Mayday I/F         \$10         \$10         \$10         \$10         \$10         \$10           Personal Route Guidance         \$11         \$10         \$10         \$10         \$10         \$10           Parking Management         \$6         \$15         \$10         \$10         \$10         \$10           Data Collection and ITS Planning         \$0         \$35         \$2         \$1         \$1         \$1	ISP6	Interactive Infrastructure Information	\$329	\$378	\$794	\$118	\$235	\$471	
ISP Probe Information Collection         \$0         \$250         \$0         \$0           Personal Basic Information Reception         \$93         \$491         \$1,813         \$22         \$138           Personal Interactive Information Reception         \$10         \$367         \$1,304         \$7         \$264           Personal Mayday I/F         \$93         \$5,743         \$25,883         \$1,004         \$1,004           Personal Route Guidance         \$118         \$7,287         \$15,388         \$2,385           Personal Route Guidance         \$65         \$157         \$109         \$362           Data Collection and ITS Planning         \$0         \$35         \$20         \$450	ISP7	ISP Advanced Integrated Control Support	\$0	\$0	\$0	\$0	\$0	\$0	
Personal Basic Information Reception         \$93         \$491         \$1,813         \$22         \$138           Personal Interactive Information Reception         \$10         \$367         \$1,304         \$7         \$264           Personal Mayday I/F         \$93         \$5,743         \$25,883         \$16         \$1,004           Personal Route Guidance         \$118         \$7,287         \$15,388         \$2,385           Parking Management         \$65         \$157         \$503         \$109         \$362           Data Collection and ITS Planning         \$0         \$35         \$0         \$450	ISP8	ISP Probe Information Collection	\$0	\$0	\$250	\$0	\$0	\$13	
Personal Interactive Information Reception         \$10         \$367         \$1,304         \$7         \$264           Personal Mayday I/F         \$93         \$5,743         \$25,883         \$16         \$1,004           Personal Route Guidance         \$118         \$7,287         \$15,388         \$2,385           Parking Management         \$65         \$157         \$503         \$109         \$362           Data Collection and ITS Planning         \$0         \$35         \$0         \$450	PIA1	Personal Basic Information Reception	\$93	\$491	\$1,813	\$22	\$138	\$407	
Personal Mayday I/F         \$93         \$5,743         \$25,883         \$16         \$1,004           Personal Route Guidance         \$118         \$7,287         \$15,388         \$2,385           I         Parking Management         \$65         \$157         \$503         \$109         \$362           Data Collection and ITS Planning         \$0         \$35         \$35         \$450         \$450	PIA2	Personal Interactive Information Reception	\$10	\$367	\$1,304	\$7	\$264	906\$	
Personal Route Guidance         \$118         \$7,287         \$1388         \$38         \$2,385           I         Parking Management         \$65         \$15,388         \$109         \$362           Data Collection and ITS Planning         \$0         \$35         \$35         \$450         \$450	PIA3	Personal Mayday I/F	\$93	\$5,743	\$25,883	\$16	\$1,004	\$4,437	
I Parking Management         \$65         \$157         \$503         \$109         \$362           Data Collection and ITS Planning         \$0         \$35         \$0         \$450	PIA4	Personal Route Guidance	\$118	\$7,287	\$15,388	\$38	\$2,385	\$4,918	
Data Collection and ITS Planning         \$0         \$35         \$0         \$450	PMS1	Parking Management	\$65	\$157	\$503	\$109	\$362	\$905	
	PS1	Data Collection and ITS Planning	0\$	\$35	\$35	\$0	\$450	\$450	

EP ID         Equipment Package Name         1'5         6-10         11-20         5 Morage Annual Expenditures           RS1         Automated and Equipment Package Name         1'5         6-10         11-20         5 Morage Annual Expenditures           RS1         Automated and Equipment Package Name         1'5         6-10         11-20         5 Morage Annual Expenditures           RS1         Automated and Equipment Package Name         1'5         6-10         51-25         5 Morage Sale Sale Sale Sale Sale Sale Sale Sal		Equipment Packaç	je Expendit	ures for Low	nt Package Expenditures for Low Market Penetration	tration	;		
Package Name			Non-Recu	ırring Exper	ditures	Recurrir	ng Expenditu	res	
Particular Package Name   1-5   6-10   11-20   5   10   200			Yrs	Yrs	Yrs	Average Ar	ınual Expend	ditures	
National Protection		Equipment Package Name	1-5	6-10	11-20	5	10	20	
Recursive Perfect Beatcrack Recursive Recu	RS1	Automated road signing	\$0	\$0	\$0	\$0	\$0	\$0	
Reaching Particle Beacors   Sp. 64 650   S735   St. 65	RS10	Roadway Pollution and Environmental Hazards Indicators	\$0	\$2,600	\$4,175	\$0	\$15	\$30	
Roadway Placement Control         \$6         \$4.650         \$2.20         \$7.15         \$1.25         \$1.25           Roadway Placement And Markey Speciment Cut Arist         \$6.00         \$6.00         \$1.00         \$6.00         \$1.00         \$6.00         \$1.00         \$6.00	RS11	Roadway Probe Beacons	\$0	\$275	\$735	\$0	\$28	\$46	
Readway Flates Styring Production Collision System for A HS         \$5,400         \$5,724         \$1000         \$5,00	RS12	Roadway Reversible Lanes	\$0	\$4,650	\$250	\$0	\$125	\$125	
Roadbaye Prevale Signal Signal         \$57.24         \$56.0         \$57.724         \$56.0         \$57.724         \$56.0         \$57.724         \$56.0         \$57.724         \$56.0         \$57.0	RS13	Roadway Systems for AHS	\$	\$0	\$1,000	\$0	\$0	\$100	
Readlate Signal Priority         \$624         \$1.352         \$4.704         \$5         \$1.50         \$5.104         \$5         \$1.50         \$5.104         \$5         \$1.50         \$5.10         \$5         \$1.50         \$5.10         \$5         \$1.50         \$5         \$1.50         \$5         \$1.50         \$5         \$1.50         \$5         \$1.50         \$5         \$1.50         \$2.50 </td <td>RS14</td> <td>Roadway Traffic Information Dissemination</td> <td>\$5,400</td> <td>\$5,724</td> <td>\$36</td> <td>\$213</td> <td>\$426</td> <td>\$426</td> <td></td>	RS14	Roadway Traffic Information Dissemination	\$5,400	\$5,724	\$36	\$213	\$426	\$426	
Readway Freework Centrols   \$1,050   \$1,050   \$2,040   \$1,050   \$2,040   \$1,050   \$2,040   \$1,050	RS2	Roadside Signal Priority	\$624	\$1,352	\$4,784	\$2	\$13	\$31	
Readway Egual Controls         \$0         \$7.00.60         \$0         \$4.290         \$6.994           Readway Egual Controls         \$0         \$7.00.60         \$7.00         \$6.0         \$4.290         \$6.994           Readway Invalidation         \$0         \$3.02.5         \$5.50         \$6.0         \$7.80         \$7.80           Readway Invalidation Detection         \$0         \$3.02.5         \$6.00         \$6.0         \$7.80         \$7.80           Readway Intersection Collision System         \$0         \$1.680         \$6.00         \$6.0         \$6.0         \$6.0           Readway Intersection Collision System         \$0         \$1.680         \$6.0         \$6.0         \$6.0         \$6.0         \$6.0           Readway Intersection Collision System         \$1         \$1.660         \$0         \$6.0 <t< td=""><td>RS3</td><td>Roadway Freeway Control</td><td>0\$</td><td>\$1,050</td><td>\$2,640</td><td>\$0</td><td>\$53</td><td>\$80</td><td></td></t<>	RS3	Roadway Freeway Control	0\$	\$1,050	\$2,640	\$0	\$53	\$80	
Readway Basic Surveillance   \$50   \$70,050	RS4	Roadway Signal Controls	\$	\$0	\$0	\$0	\$0	\$0	
Readway Information Description         \$5,025         \$5,026         \$190         \$180           Readway Information Reception         \$0         \$1,820         \$0         \$150         \$150           Readway Indicated Description Collision System         \$0         \$1,680         \$1,440         \$0         \$1,833           Readway Indicated Description Collision System         \$1         \$1,660         \$0         \$628         \$1,833           Remote Management         \$1         \$1         \$1,660         \$0         \$628         \$1,833           Remote Management         \$520         \$261         \$4,850         \$88         \$1,660         \$60           Remote Basic Information Reception         \$520         \$261         \$4,850         \$88         \$1,660         \$60           Remote Basic Information Reception         \$520         \$50         \$60         \$60         \$60         \$60           Tool Page Tool Collection Pystem         \$520         \$50         \$50         \$50         \$50         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60	RS5	Roadway Basic Surveillance	\$0	\$70,050	\$70,000	\$0	\$4,290	\$6,994	
Roadway In-Verlote Signing         \$2         \$240         \$630         \$16         \$30           Roadway In-Verlote Signing         \$0         \$1,680         \$1,440         \$0         \$14           Roadway Intersactive Information Reception         \$0         \$416         \$1,680         \$0         \$0         \$183           Remote Internative Information Reception         \$0         \$416         \$1,680         \$86         \$16         \$24           Remote Internative Information Reception         \$50         \$60         \$20         \$60         \$24           Remote Transit Socurity Information Reception         \$56         \$10         \$20         \$24         \$20         \$24           Remote Transit Socurity Information Communication         \$60         \$10         \$20         \$24         \$20         \$24           Remote Transit Socurity Information Communication         \$60         \$10         \$20         \$24         \$20         \$24         \$20         \$24         \$20         \$24         \$20         \$24         \$20         \$24         \$20         \$24         \$24         \$20         \$24         \$24         \$20         \$24         \$24         \$20         \$24         \$20         \$24         \$20         \$24	RS6	Roadway HOV Usage	<b>\$</b>	\$3,025	\$250	\$0	\$180	\$180	
Readway Intersection         \$1,680         \$1,440         \$0         \$84         \$114           Readway Intersection Collection System         \$6         \$1,660         \$0         \$628         \$1,883           Remote Mayday IF         \$1         \$4         \$20         \$66         \$1,660         \$1         \$1           Remote Mayday IF read Management         \$60         \$1,660         \$6         \$1,660         \$1	RS7	Roadway In-Vehicle Signing	<b>\$</b>	\$240	\$630	\$0	\$15	\$30	
Reaction Collision System         \$0         \$1,660         \$0         \$1,882           Remote Metalschier Information Reception         \$1,600         \$0         \$1,882         \$1,882           Remote Metalschier Information Reception         \$1         \$20         \$1,882         \$16         \$560           Remote Management         \$520         \$961         \$4,850         \$96         \$16         \$560           Remote Transit Face Management         \$520         \$50         \$10         \$244         \$16         \$560           Remote Transit Security IF         \$60         \$10         \$20         \$10         \$249         \$249         \$249           Remote Transit Security IF         \$60         \$10         \$10         \$10         \$249         \$10         \$10           Toll Administration         \$60         \$10         \$10         \$249         \$10         \$10         \$10           Toll Administration         \$10	RS8	Roadway Incident Detection	\$	\$1,680	\$1,440	\$0	\$84	\$114	
Remote Interactive Information Reception         \$415         \$1660         \$628         \$1,883           Remote Interactive Information Reception         \$51         \$41         \$160         \$62         \$62           Remote Transit Eare Management         \$520         \$661         \$450         \$66         \$624           Remote Transit Eare Management         \$529         \$561         \$510         \$60         \$624           Remote Transit Eare Management         \$567         \$61         \$561         \$66         \$68         \$68           Into Administration         \$567         \$10         \$56         \$10         \$66         \$68         \$68           Toll Administration         \$10         \$56         \$10         \$66         \$10         \$68         \$68         \$68         \$10         \$60         \$1	RS9	Roadway Intersection Collision System	\$0	\$0	\$0	\$0	\$0	\$0	
Remote Mayday I/F         \$1         \$4         \$20         \$86         \$16         \$60           Remote Mandagement         \$20         \$961         \$4,850         \$86         \$165         \$60           Remote Basic Information Reception         \$597         \$0         \$500         \$0         \$20           Toll Administration         \$460         \$504         \$50         \$4,850         \$49         \$49         \$49           Toll Administration         \$450         \$50         \$50         \$54         \$49         \$49         \$49           Toll Plezz Closer Traffic Surveillance         \$58         \$50         \$50         \$510         \$510         \$510         \$510           Toll Plezz Closer Traffic Surveillance         \$10         \$50         \$50         \$50         \$50         \$510         \$5	RTS1	Remote Interactive Information Reception	\$0	\$415	\$1,660	\$0	\$628	\$1,883	
Remote Transit Face Management         \$520         \$961         \$4,850         \$86         \$165         \$660           Remote Transit Face Management         \$527         \$524         \$60         \$98         \$564         \$244           Remote Transit Security IrF         Remote Transit Security IrF         \$60         \$50         \$60         \$549         \$540         \$540         \$540         \$540         \$540         \$540         \$540         \$540         \$540         \$540         \$540 <td< td=""><td>RTS2</td><td>Remote Mayday I/F</td><td>\$1</td><td>\$4</td><td>\$20</td><td>\$8</td><td>\$16</td><td>\$62</td><td></td></td<>	RTS2	Remote Mayday I/F	\$1	\$4	\$20	\$8	\$16	\$62	
Remote Transit Security I/F         \$0         \$0         \$0         \$244         \$246	RTS3	Remote Transit Fare Management	\$520	\$961	\$4,850	\$86	\$165	\$660	
Remote Basic Information Reception         \$597         \$55187         \$108         \$208         \$830           Toll Administration         \$456         \$10         \$49         \$49         \$49           Toll Administration         \$456         \$10         \$49         \$49         \$49           Collect Tailfo Collection         \$408         \$58         \$68         \$136         \$136           TMC Incident Dispatch Coordination         \$10         \$0         \$0         \$0         \$0         \$10         \$140         \$180           TMC Incident Dispatch Coordination         \$10         \$0	RTS4	Remote Transit Security I/F	\$0	\$0	\$300	\$0	\$0	\$244	
Toll Administration         \$66         \$10         \$49         \$49           Toll Padministration         \$450         \$240         \$110         \$110           Toll Plaza Toll Collection         \$368         \$240         \$110         \$110           Toll Plaza Toll Collection         \$368         \$268         \$568         \$136           Toll Cinque to Plaza Toll Condination Condination         \$10         \$50         \$0         \$0           Toll Cinque to InvAnicles Signing         \$0         \$0         \$0         \$0         \$0         \$0           Toll Cinque to InvAnicles Signing         \$0	RTS5	Remote Basic Information Reception	\$597	\$551	\$5,187	\$108	\$208	\$830	
Toll Plaza Toll Collection         \$450         \$0         \$240         \$110         \$	TAS1	Toll Administration	\$56	\$10	\$60	\$49	\$49	\$49	
Collect Traffic Surveillance         \$368         \$68         \$68         \$136           1         TMC Incident Dispatch Coordination/Communication         \$199         \$27         \$278         \$592         \$183           1         TMC Incident Dispatch Coordination Coordination         \$199         \$50         \$60 <td< td=""><td>TCS1</td><td>Toll Plaza Toll Collection</td><td>\$450</td><td>\$0</td><td>\$240</td><td>\$110</td><td>\$110</td><td>\$110</td><td></td></td<>	TCS1	Toll Plaza Toll Collection	\$450	\$0	\$240	\$110	\$110	\$110	
1 Info Incident Dispatch Coordination/Communication         \$199         \$32         \$278         \$92         \$183           1 Info Incident Dispatch Coordination         \$10         \$0	TMS1	Collect Traffic Surveillance	\$368	\$0	\$368	\$68	\$68	\$136	
1         TMC Input to In-Vehicle Signing         \$0         \$0         \$0         \$0         \$0           2         TMC Multi-Modal Coordination         \$109         \$140         \$140         \$280           3         TMC Probe Information Collection         \$0         \$14         \$158         \$0         \$14         \$233           4         TMC Toll/Parking Coordination         \$0         \$14         \$159         \$0         \$14         \$233           5         TMC Traffic Untromation Dissemination         \$0         \$14         \$153         \$0         \$14         \$233           5         TMC Traffic Network Performance Evaluation         \$0         \$14         \$156         \$0         \$14         \$156         \$0         \$14         \$150         \$239         \$150	TMS10	TMC Incident Dispatch Coordination/Communication	\$199	\$32	\$278	\$92	\$92	\$183	
2         TMC Multi-Modal Coordination         \$109         \$61         \$140         \$180         \$280           3         TMC Probe Information Collection         \$0         \$114         \$158         \$0         \$61         \$15         \$23           4         TMC Probe Information Dissemination         \$0         \$114         \$159         \$0         \$11         \$23	TMS11	TMC Input to In-Vehicle Signing	0\$	\$0	\$0	\$0	\$0	\$0	
3 TMC Probe Information Collection         \$0         \$158         \$0         \$61           4 TMC Probe Information Coordination         \$0         \$114         \$159         \$0         \$11         \$23           5 TMC Traffic Information Dissemination         \$0         \$117         \$163         \$0         \$12         \$23           5 TMC Traffic Network Performance Evaluation         \$0 <td>TMS12</td> <td>TMC Multi-Modal Coordination</td> <td>\$109</td> <td>\$0</td> <td>\$109</td> <td>\$140</td> <td>\$140</td> <td>\$280</td> <td></td>	TMS12	TMC Multi-Modal Coordination	\$109	\$0	\$109	\$140	\$140	\$280	
1 TMC Toll/Parking Coordination         \$0         \$114         \$159         \$0         \$11         \$23           5 TMC Traffic Information Dissemination         \$0         \$117         \$163         \$0         \$120         \$239           5 TMC Traffic Network Performance Evaluation         \$0<	TMS13	TMC Probe Information Collection	<b>\$</b>	\$0	\$158	\$0	\$0	\$61	
5         TMC Traffic Information Dissemination         \$0         \$117         \$163         \$0         \$239           5         TMC Traffic Network Performance Evaluation         \$0 <td>TMS14</td> <td>TMC Toll/Parking Coordination</td> <td>0\$</td> <td>\$114</td> <td>\$159</td> <td>\$0</td> <td>\$11</td> <td>\$23</td> <td></td>	TMS14	TMC Toll/Parking Coordination	0\$	\$114	\$159	\$0	\$11	\$23	
5         TMC Traffic Network Performance Evaluation         \$0         \$1,653         \$0         \$0         \$994           7         Traffic Naintenance         \$0         \$20         \$60         \$0         \$180           8         \$0         \$0         \$0         \$0         \$0         \$180           9         \$0         \$0         \$0         \$0         \$0         \$0           1         TMC Advanced Signal Control         \$0 <t< td=""><td>TMS15</td><td>TMC Traffic Information Dissemination</td><td>\$</td><td>\$117</td><td>\$163</td><td>\$0</td><td>\$120</td><td>\$239</td><td></td></t<>	TMS15	TMC Traffic Information Dissemination	\$	\$117	\$163	\$0	\$120	\$239	
7         Traffic Maintenance         \$0         \$20         \$60         \$0         \$180         \$180           Distributed Road Management         \$0         \$0         \$0         \$0         \$0         \$0         \$0           TMC Advanced Signal Control         \$0         \$0         \$208         \$0         \$0         \$304         \$0           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0         \$205           TMC Basic Signal Control         \$0 <td>TMS16</td> <td>TMC Traffic Network Performance Evaluation</td> <td>\$0</td> <td>\$0</td> <td>\$1,653</td> <td>\$0</td> <td>\$0</td> <td>\$994</td> <td></td>	TMS16	TMC Traffic Network Performance Evaluation	\$0	\$0	\$1,653	\$0	\$0	\$994	
Distributed Road Management         \$0         \$0         \$0         \$0         \$0           TMC Advanced Signal Control         \$0         \$0         \$208         \$0         \$0         \$304           TMC Regional Traffic Control         \$0         \$0         \$0         \$0         \$205         \$205           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0         \$0           TMC Basic Signal Control         \$0 <t< td=""><td>TMS17</td><td>Traffic Maintenance</td><td>\$</td><td>\$20</td><td>\$60</td><td>\$0</td><td>\$30</td><td>\$180</td><td></td></t<>	TMS17	Traffic Maintenance	\$	\$20	\$60	\$0	\$30	\$180	
TMC Advanced Signal Control         \$0         \$208         \$0         \$304         \$304           TMC Regional Traffic Control         \$0         \$0         \$364         \$0         \$0         \$205           TMC based Freeway Control         \$0         \$0         \$0         \$0         \$0         \$460           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0           TMC Con AHS         TMC Incident Detection         \$0         \$231         \$557         \$0         \$0         \$0           TMC Incident Detection         \$0         \$302         \$727         \$0         \$1,290         \$1,290           Fleet Maintenance Management         \$0         \$121         \$121         \$1         \$1         \$1	TMS2	Distributed Road Management	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Regional Traffic Control         \$0         \$364         \$0         \$205           TMC based Freeway Control         \$0         \$0         \$0         \$460           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0           TMC Rasic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0           TMC for AHS         TMC for AHS         \$0         \$0         \$0         \$0         \$0           TMC HOV/Reversible Lane Management         \$0         \$231         \$557         \$0         \$174           TMC Incident Detection         \$0         \$121         \$121         \$0         \$129           Fleet Maintenance Management         \$0         \$121         \$121         \$121         \$121	TMS3	TMC Advanced Signal Control	\$0	\$0	\$208	\$0	\$0	\$304	
TMC based Freeway Control         \$0         \$0         \$391         \$0         \$460           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0           TMC Rasic Signal Control         \$0         \$0         \$0         \$0         \$0         \$0           TMC for AHS         TMC HOV/Reversible Lane Management         \$0         \$231         \$657         \$0         \$174           TMC HOV/Reversible Lane Management         \$0         \$302         \$727         \$0         \$1,290           Fleet Maintenance Management         \$0         \$121         \$121         \$0         \$1	TMS4	TMC Regional Traffic Control	\$0	\$0	\$364	\$0	\$0	\$205	
TMC Basic Signal Control         \$0         \$	TMS5	TMC based Freeway Control	0\$	\$0	\$391	\$0	\$0	\$460	
TMC for AHS         \$0         \$0         \$0         \$0         \$0           TMC HOV/Reversible Lane Management         \$0         \$231         \$557         \$0         \$107         \$214           TMC Incident Detection         \$0         \$302         \$727         \$0         \$1,290           Fleet Maintenance Management         \$0         \$121         \$121         \$0         \$7         \$14	TMS6	TMC Basic Signal Control	\$	\$0	\$0	\$0	\$0	\$0	
TMC HOV/Reversible Lane Management         \$0         \$231         \$557         \$0         \$107         \$214           TMC Incident Detection         \$0         \$302         \$727         \$0         \$645         \$1,290           Fleet Maintenance Management         \$0         \$121         \$121         \$0         \$7         \$14	TMS7	TMC for AHS	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Incident Detection         \$0         \$302         \$727         \$0         \$645         \$1,290           Fleet Maintenance Management         \$0         \$121         \$0         \$7         \$14	TMS8	TMC HOV/Reversible Lane Management	\$	\$231	\$557	\$0	\$107	\$214	
Fleet Maintenance Management	TMS9	TMC Incident Detection	\$0	\$302	\$727	\$0	\$645	\$1,290	
	TRM1	Fleet Maintenance Management	\$0	\$121	\$121	\$0	2\$	\$14	

		Non-Rect	Non-Recurring Expenditures	ditures	Recurri	Recurring Expenditures	ures	
		Yrs	Yrs	Yrs	Average A	<b>Average Annual Expenditures</b>	ditures	
EP ID	Equipment Package Name	1-5	6-10	11-20	2	10	20	
TRM2	Transit Center Fare and Load Management	\$	\$292	\$292	\$0	\$7	\$14	
TRM3	Transit Center Fixed-Route Operations	\$249	\$249	\$249	\$231	\$462	\$694	
TRM4	Transit Center Multi-Modal Coordination	\$	\$0	\$0	\$0	\$0	\$0	
TRM5	Transit Center Paratransit Operations	\$140	\$140	\$140	\$1	\$2	\$2	
TRM6	Transit Center Security	<b>%</b>	\$321	\$391	\$0	\$205	\$409	
TRM7	Transit Center Tracking and Dispatch	\$	\$1,694	\$877	\$0	\$535	\$802	
TRV1	On-board Maintenance	\$	\$555	\$929	\$0	\$275	\$461	
TRV2	On-board Transit Driver I/F	\$892	\$1,017	\$3,295	\$198	\$415	\$695	
TRV3	On-board Transit Fare and Load Management	<b>%</b>	\$493	\$826	\$0	\$580	\$970	
TRV4	On-board Transit Security	<b>%</b>	\$841	\$2,821	\$0	\$80	\$268	
TRV5	On-board Vehicle Signal Coordination	\$	\$195	\$654	\$0	\$6	\$21	
TRV6	Vehicle Dispatch Support	\$0	\$0	\$0	\$0	\$74	\$124	
TRV7	On-board Trip Monitoring	\$167	\$183	\$585	\$262	\$550	\$921	
VS1	Basic Vehicle Reception	\$1,703	\$7,575	\$52,951	\$0	\$0	\$0	
VS10	Vehicle Lateral Control	\$0	\$0	\$0	\$0	\$0	\$0	
VS11	Vehicle Lateral Warning System	\$	\$0	\$17,937	\$0	\$0	\$512	
VS12	Vehicle Longitudinal Control	\$0	\$0	\$7,687	\$0	\$0	\$512	
VS13	Vehicle Longitudinal Warning System	\$0	\$15,642	\$86,404	\$0	\$447	\$2,469	
VS14	Vehicle Mayday I/F	\$6,385	\$12,171	\$44,821	\$3,320	\$9,649	\$19,987	
VS15	Vehicle Pre-Crash Safety Systems	<b>%</b>	\$0	\$11,275	\$0	\$0	\$410	
VS16	Vehicle Route Guidance	\$2,043	\$12,802	\$43,042	\$868	\$6,309	\$17,425	
VS17	Vehicle Safety Monitoring System	\$2,213	\$9,848	\$68,837	\$170	\$928	\$5,125	
VS18	Vehicle Systems for AHS	\$	\$0	\$1,076	\$0	\$0	\$31	
VS19	Vehicle Toll/Parking I/F	\$341	\$402	\$4,440	\$0	\$0	\$0	
VS2	Driver Safety Monitoring System	\$0	\$3,990	\$44,074	\$0	\$278	\$3,075	
VS3	Driver Visibility Improvement System	\$0	\$0	\$12,300	\$0	\$0	\$615	
VS4	In-Vehicle Signing System	\$0	\$1,484	\$16,400	\$0	\$93	\$1,025	
VS5	Interactive Vehicle Reception	\$255	\$2,528	\$7,430	\$153	\$1,670	\$4,305	
NS6	Probe Vehicle Software	<b>%</b>	\$464	\$1,025	\$0	\$93	\$205	
/S7	Smart Probe	\$0	\$0	\$0	\$0	\$0	\$0	
NS8	Vehicle Intersection Collision Warning	\$0	\$0	\$0	\$0	\$0	\$0	
NS9	Vehicle Intersection Control	\$0	\$0	\$0	\$0	\$0	\$0	
	FIGURE 6.3-1 THRUVILLE SUMMARY EQUIPMENT PACKAGE EXPENDITURES FOR LOW MARKET PENETRATION	ACKAGE EXPENDITUF	RES FOR LOW MAF	RKET PENETRATIC	Z			194

	Equipment Packag	Package Expenditures for High Market Penetration	es for High N	Narket Penet	ration			
		Non-Reci	Non-Recurring Expenditures	ditures	Recurring	Recurring Expenditures	ures	
		Yrs	Yrs	Yrs	Average Ar	Average Annual Expenditures	ditures	
EP ID	Equipment Package Name	1-5	6-10	11-20	2	10	20	
CVA1	Credentials and Taxes Administration	\$553	\$1	\$32	\$562	\$562	\$562	
CVA2	CV Information Exchange	\$43	\$0	\$0	\$154	\$154	\$154	
CVA3	CV Safety Administration	\$80	\$0	\$0	\$0	\$0	\$0	
CVA4	International CV Administration	\$0	\$0	\$0	\$0	\$0	\$0	
CVC1	Citation and Accident Electronic Recording	\$40	\$0	\$0	\$3	\$3	\$3	
CVC2	International Border Crossing	\$0	\$0	\$0	\$0	\$0	\$0	
CVC3	Roadside Electronic Screening	\$651	\$0	\$160	\$17	\$17	\$17	
CVC4	Roadside Safety Inspection	\$88	\$6	\$12	\$5	\$5	\$2	
CVC5	Roadside WIM	\$30	\$0	\$30	\$2	\$2	\$2	
CVS1	On-board Cargo Monitoring	\$65	\$71	\$751	\$170	\$322	\$1,964	
CVS2	On-board CV Electronic Data	\$36	\$340	\$1,661	\$10	\$110	\$485	
CVS3	On-board CV Safety	\$77	\$328	\$1,341	\$2	\$12	\$38	
CVS4	On-board Trip Monitoring	\$2,857	\$9,139	\$53,006	\$329	\$1,506	\$6,655	
EM1	Emergency and Incident Management Communication	\$6	\$6	\$1	\$2	\$15	\$15	
EM2	Emergency Mayday and E-911 I/F	\$105	\$105	\$210	\$2	\$2	\$2	
EM3	Emergency Response Management	\$91	\$91	\$180	\$136	\$273	\$273	
EM4	Emergency Vehicle Routing and communications	\$	\$1	\$2	\$1	\$2	\$2	
EMM1	Emissions and Environmental Data Management	\$0	\$1	\$0	\$0	\$107	\$107	
EVS1	On-board EV Incident Management Communication	\$490	\$1,271	\$2,946	\$81	\$291	\$487	
EVS2	On-board Vehicle Signal Coordination	\$405	\$1,050	\$2,434	\$89	\$322	\$538	
FMS1	Fleet Administration	\$1,068	\$716	\$1,460	\$16	\$26	\$47	
FMS2	Fleet Credentials and Taxes Management and Reporting	\$932	\$99\$	\$1,397	\$1,026	\$1,711	\$3,079	
FMS3	Fleet HAZMAT Management	\$27	\$0	\$32	\$1	\$1	\$2	
FMS4	Freight Administration and Management	\$6	\$4	\$18	\$4	\$6	\$11	
FMS5	Fleet Maintenance Management	\$362	\$241	\$482	\$22	\$36	\$65	
ISP1	Basic Information Broadcast	\$422	\$493	\$1,156	\$316	\$631	\$1,262	
ISP2	EM Route Plan Information Dissemination	\$0	\$64	\$218	\$0	\$3	\$11	
ISP3	Infrastructure Provided Dynamic Ridesharing	\$0	\$106	\$224	\$0	\$156	\$469	
ISP4	Infrastructure Provided Route Selection	\$0	\$200	\$1,700	\$0	\$25	\$20	
ISP5	Infrastructure Provided Yellow Pages & Reservation	\$356	\$361	\$733	\$118	\$236	\$473	
ISP6	Interactive Infrastructure Information	\$329	\$378	\$794	\$118	\$235	\$471	
ISP7	ISP Advanced Integrated Control Support	\$0	\$0	\$431	\$0	\$0	\$21	
ISP8	ISP Probe Information Collection	\$0	\$250	\$200	\$0	\$13	\$38	
PIA1	Personal Basic Information Reception	\$926	\$1,408	\$18,119	\$219	\$552	\$4,067	
PIA2	Personal Interactive Information Reception	\$100	\$528	\$2,873	\$20	\$439	\$1,941	
PIA3	Personal Mayday I/F	\$926	\$10,745	\$35,312	\$159	\$2,008	\$5,916	
PIA4	Personal Route Guidance	\$1,175	\$13,634	\$33,898	\$378	\$4,769	\$10,538	
PMS1	Parking Management	\$172	\$231	\$905	\$290	\$652	\$1,629	
PS1	Data Collection and ITS Planning	\$0	\$35	\$35	\$0	\$450	\$450	
	FIGURE 6.3-2 THRUVILLE SUMMARY EQUIPMENT PACKAGE EXPENDITURES FOR HIGH MARKET PENETRATION	E EXPENDITURES F	OR HIGH MARKET	PENETRATION				195
				-		_	_	?

Proceedings   Proceding   Pr		Equipment Packag	Package Expenditures for High Market Penetration	es for High N	<b>larket Penet</b>	ration			
Price and protection of the control of the			Non-Rect	urring Expen	ditures	Recurrir	ng Expendit	ures	
Namework problems (conditional problems)         1-5         6-10         11-20         5-7         10-7         20-7         10-7         10-7         All conditions and transformed placement from the functions and transformed placement from the function from			Yrs	Yrs	Yrs	Average Ar	nnual Expen	ditures	
Accordance to the Engineery Control Registration   State   S		Equipment Package Name	1-5	6-10	11-20	2	10	20	
Roadway Protein Beacons   St. 26.00   St. 175   St. 17	RS1	Automated road signing	\$0	\$0	\$0	\$0	\$0	\$0	
Recombine Langest   State	RS10	Roadway Pollution and Environmental Hazards Indicators	\$0	\$2,600	\$4,175	\$0	\$15	\$30	
Readwaye Selection the AISI         \$6         \$66.00         \$50.00         \$10.00	RS11	Roadway Probe Beacons	\$0	\$275	\$735	\$0	\$28	\$46	
Readway Signal Control         \$5,400         \$100         \$5,100         \$100 <th< td=""><td>RS12</td><td>Roadway Reversible Lanes</td><td>\$0</td><td>\$4,650</td><td>\$250</td><td>\$0</td><td>\$125</td><td>\$125</td><td></td></th<>	RS12	Roadway Reversible Lanes	\$0	\$4,650	\$250	\$0	\$125	\$125	
Roadway Present Signal Signal Signal Signal Signal Signal Priority         \$12.60	RS13	Roadway Systems for AHS	\$0	\$0	\$1,000	\$0	\$0	\$100	
Reaching protection   S1,248   \$2,704   \$7,344   \$10	RS14	Roadway Traffic Information Dissemination	\$5,400	\$5,824	\$136	\$213	\$426	\$426	
Readway Eleave) Currol Carrol Carro	RS2	Roadside Signal Priority	\$1,248	\$2,704	\$7,384	\$10	\$26	\$44	
Reconting Signal Controls         \$0         \$7.0 GeO         \$0         \$4.2 Geo         \$6.9 Geo           Reconting Back Survey Controls         \$0         \$7.0 CeO         \$0         \$4.2 Geo         \$6.9 Geo           Reconting Household         \$0         \$3.00E         \$5.00E         \$5.00E         \$6.9 Geo         \$1.0 Geo           Reconting Household         \$0         \$1.00E         \$1.0 Geo         \$1.0 Geo         \$1.0 Geo         \$1.0 Geo         \$1.0 Geo           Reconting Inclination Recoption         \$0         \$1.0 Geo         \$2.0 Geo         \$2.0 Geo         \$2.0 Geo         \$1.0 Geo	RS3	Roadway Freeway Control	\$0	\$1,590	\$3,690	\$0	\$80	\$105	
Readway In-Verlicito Signific         \$6,904         \$70,005         \$70,000         \$6,904         \$6,904           Readway In-Verlicito Signific         \$0         \$70,000         \$6,000         \$6,904         \$6,904           Readway In-Verlicito Signific         \$0         \$2,40         \$6,00         \$18         \$180           Readway In-Verlicito Signific         \$0         \$1,40         \$0         \$18         \$10           Readway In-Verlicito Signific         \$0         \$1,680         \$1,440         \$0         \$18           Readway Intersection Collision System         \$0         \$1,680         \$1,440         \$0         \$10           Remote Intersective Information Reception         \$2,10         \$2,00         \$20         \$20         \$10           Remote Transit Face Amengement         \$50         \$3,00         \$20         \$20         \$10           Remote Transit Face Amengement         \$50         \$50         \$50         \$24         \$10           Remote Transit Security Inferestation         \$50         \$50         \$50         \$50         \$10           Remote Transit Security Inferestation         \$50         \$50         \$50         \$50         \$50           Remote Preference Intersective Information Reception	RS4	Roadway Signal Controls	\$0	\$0	\$0	\$0	\$0	\$0	
Readway Inviside Signing         \$0         \$3.025         \$2.50         \$18.0         \$18.0           Readway Inviside Signing         \$0         \$1.60         \$1.44         \$0         \$1.60         \$1.60           Readway Inviside Signing         \$0         \$1.60         \$1.44         \$0         \$0         \$1.43           Readway Inviside Description         \$0         \$1.60         \$1.44         \$0         \$0         \$1.43           Remote Mayaday Ir Remote Mayad	RS5	Roadway Basic Surveillance	\$0	\$70,050	\$70,000	\$0	\$4,290	\$6,994	
Readway Inchite Signified   September	RS6	Roadway HOV Usage	\$0	\$3,025	\$250	\$0	\$180	\$180	
Reaction Description         \$1680         \$1,680         \$1,440         \$0         \$144         \$1	RS7	Roadway In-Vehicle Signing	\$0	\$240	\$630	\$0	\$15	\$30	
Remote between functional Displacement Remote Mayday In Free Remote Mayday In Free Management Reception         \$60         \$80         \$60	RS8	Roadway Incident Detection	\$0	\$1,680	\$1,440	\$0	\$84	\$114	
Remote Interactive Information Reception         \$216         \$415         \$2,075         \$526         \$52,510           Remote Interactive Information Reception         \$50         \$416         \$62         \$62         \$62           Remote Management         \$50         \$50         \$60         \$165         \$60         \$62           Remote Interactive Interaction         \$60         \$60         \$60         \$60         \$60         \$60         \$60         \$60           Interaction Interaction         \$60	RS9	Roadway Intersection Collision System	\$0	\$0	\$0	\$0	\$0	\$0	
Remote Mayday VF         \$60         \$15         \$20         \$15         \$20           Remote Mayday VF         Remote Mayday VF         \$60         \$961         \$4,850         \$165         \$165         \$600           Remote Transt Searing VF         \$60         \$300         \$300         \$204         \$700           Remote Basic Information Reception         \$160         \$200         \$200         \$200         \$200           Remote Basic Information Reception         \$160         \$200         \$200         \$200         \$200           To I I Administration         \$10	RTS1	Remote Interactive Information Reception	\$216	\$415	\$2,075	\$326	\$628	\$2,510	
Remote Transit Fare Management         \$20         \$961         \$4,850         \$660         \$660           Remote Transit Fare Management         \$50         \$500         \$900         \$60         \$244         \$732           Remote Transit Security I/F         \$60         \$50         \$50         \$50         \$60         \$50           Toll Plazar Toll Collection         \$56         \$10         \$60         \$49         \$49         \$49           Toll Plazar Toll Collection         \$50         \$50         \$50         \$50         \$510         \$510           Toll Plazar Toll Collection         \$50         \$50         \$50         \$50         \$510         \$510           TMC Incident Dispetch Coordination Collection         \$10         \$50         \$50         \$50         \$50         \$50         \$50           TMC Probe Information Collection         \$10         \$50	RTS2	Remote Mayday I/F	\$0	\$3	\$20	\$0	\$16	\$62	
Remote Transit Security IF         \$0         \$30         \$30         \$324         \$732           Remote Transit Security IF         Remote Transit Security IF         \$69         \$651         \$61         \$108         \$224         \$30           Remote Dassic Information Reception         \$56         \$10         \$66         \$49         \$49         \$49           Toll Administration         \$56         \$10         \$60         \$240         \$110         \$410         \$110           Toll Indicat Dispetal Condition Communication         \$199         \$20         \$20         \$60	RTS3	Remote Transit Fare Management	\$520	\$961	\$4,850	\$86	\$165	\$660	
Remote Basic Information Reception         \$556         \$551         \$518         \$108         \$208         \$830           Toll Administration         \$56         \$10         \$40         \$49         \$49         \$49           Toll Administration         \$136         \$10         \$240         \$110         \$110         \$110         \$116	RTS4	Remote Transit Security I/F	\$0	\$300	006\$	\$0	\$244	\$732	
Toll Administration         \$66         \$10         \$60         \$49         \$49         \$49           Toll Plazar Toll Collection         \$450         \$450         \$240         \$110         \$110           Collection         \$580         \$58         \$58         \$110         \$110           Collection         \$580         \$58         \$58         \$136         \$136           TMC Incident Dispatch Coordination/Communication         \$109         \$22         \$278         \$59         \$183           TMC Incident Dispatch Coordination/Communication         \$10         \$1         \$1         \$1         \$1           TMC Incident Dispatch Coordination         \$114         \$23         \$214         \$61         \$14         \$280           TMC Maltin Model Coordination         \$114         \$23         \$14         \$61         \$14         \$23           TMC Toll/Parking Coordination         \$117         \$23         \$156         \$10         \$10         \$10           TMC Tallic Information Dissemination         \$117         \$23         \$158         \$10         \$10         \$10           TMC Tallic Information Dissemination         \$11         \$23         \$156         \$10         \$10         \$10	RTS5	Remote Basic Information Reception	\$297	\$551	\$5,187	\$108	\$208	\$830	
Toll Plaza Toll Collection         \$450         \$0         \$240         \$110         \$110           Collect Traffic Surveillance         \$386         \$58         \$136         \$13	TAS1	Toll Administration	\$26	\$10	\$60	\$49	\$49	\$49	
Collect Traffic Surveillance         \$368         \$368         \$368         \$136         <	TCS1	Toll Plaza Toll Collection	\$450	\$0	\$240	\$110	\$110	\$110	
TMC Incident Dispatch Coordination/Communication         \$199         \$32         \$278         \$92         \$183           TMC Incident Dispatch Coordination Communication         \$109         \$0         \$0         \$0         \$0           TMC Input to in-Vehicle Signing         \$109         \$0         \$10         \$140         \$140         \$1280           TMC Input to in-Vehicle Signing         \$114         \$23         \$214         \$61         \$140         \$1280           TMC Mode Incondition         \$114         \$23         \$140         \$11         \$123         \$11         \$120         \$	TMS1	Collect Traffic Surveillance	\$368	\$0	\$368	\$68	\$68	\$136	
TMC Input to In-Vehicle Signing         \$0         \$0         \$0         \$0         \$0           TMC Multi-Modal Coordination         \$109         \$109         \$140         \$280           TMC Multi-Modal Coordination         \$114         \$23         \$141         \$122           TMC Toll/Parking Coordination         \$114         \$23         \$150         \$11         \$23           TMC Toll/Parking Coordination         \$117         \$23         \$150         \$141         \$23           TMC Toll/Parking Coordination         \$117         \$23         \$141         \$23         \$141         \$23           TMC Taffic Information Dissemination         \$147         \$23         \$163         \$141         \$23           TMC Taffic Network Performance Evaluation         \$147         \$24         \$1,754         \$497         \$180           TMC Taffic Network Performance Evaluation         \$20         \$20         \$60         \$90         \$180           TMC Taffic Network Performance Evaluation         \$10         \$10         \$10         \$10         \$10           TMC Avianced Signal Control         \$10         \$10         \$10         \$10         \$10         \$10           TMC Resized Freeway Control         \$0         \$0	TMS10	TMC Incident Dispatch Coordination/Communication	\$199	\$32	\$278	\$92	\$92	\$183	
2         TMC Multi-Modal Coordination         \$109         \$0         \$140         \$180         \$280           3         TMC Probe Information Collection         \$158         \$23         \$214         \$61         \$122           4         TMC Probe Information Collection         \$114         \$23         \$140         \$12         \$12           4         TMC Trailing Parking Coordination         \$114         \$23         \$150         \$14         \$239         \$12         \$239         \$12         \$	TMS11	TMC Input to In-Vehicle Signing	\$0	\$0	\$0	\$0	\$0	\$0	
3 TMC Probe Information Collection         \$158         \$23         \$214         \$61         \$122           1 TMC Toll/Parking Coordination         \$114         \$23         \$159         \$11         \$13           2 TMC Traffic Information Dissemination         \$117         \$23         \$120         \$120         \$239           3 TMC Traffic Information Dissemination         \$827         \$464         \$1,754         \$497         \$994         \$180           3 TMC Traffic Nationance Evaluation         \$827         \$20         \$90         \$90         \$180	TMS12	TMC Multi-Modal Coordination	\$109	\$0	\$109	\$140	\$140	\$280	
1 TMC Toul/Parking Coordination         \$114         \$23         \$159         \$11         \$13         \$24         \$24         \$24         \$24         \$24         \$24         \$24         \$24         \$24 <t< td=""><td>TMS13</td><td>TMC Probe Information Collection</td><td>\$158</td><td>\$23</td><td>\$214</td><td>\$61</td><td>\$61</td><td>\$122</td><td></td></t<>	TMS13	TMC Probe Information Collection	\$158	\$23	\$214	\$61	\$61	\$122	
5         TMC Traffic Information Dissemination         \$117         \$23         \$120         \$120         \$239           7         Traffic Network Performance Evaluation         \$827         \$464         \$1,754         \$497         \$497         \$994           7         Traffic Naintenance         \$20         \$20         \$60         \$90         \$90         \$180           7         Traffic Maintenance         \$20         \$20         \$60         \$180         \$180           8         \$20         \$20         \$0         \$0         \$0         \$0         \$0           9         Distributed Road Management         \$0         \$0         \$0         \$0         \$0         \$0           1MC Advanced Signal Control         \$0         \$10 </td <td>TMS14</td> <td>TMC Toll/Parking Coordination</td> <td>\$114</td> <td>\$23</td> <td>\$159</td> <td>\$11</td> <td>\$11</td> <td>\$23</td> <td></td>	TMS14	TMC Toll/Parking Coordination	\$114	\$23	\$159	\$11	\$11	\$23	
TIMC Traffic Network Performance Evaluation         \$827         \$464         \$1,754         \$497         \$994           7         Traffic Network Performance         \$20         \$20         \$60         \$90         \$90         \$180           Distributed Road Management         \$0         \$0         \$0         \$0         \$0         \$0         \$0           TMC Advanced Signal Control         \$0         \$0         \$415         \$0         \$0         \$0         \$0         \$0         \$0           TMC Regional Traffic Control         \$0         \$196         \$724         \$205         \$205         \$409         \$0	TMS15	TMC Traffic Information Dissemination	\$117	\$23	\$163	\$120	\$120	\$239	
7         Traffic Maintenance         \$20         \$20         \$60         \$90         \$180           Distributed Road Management         \$0         <	TMS16	TMC Traffic Network Performance Evaluation	\$827	\$464	\$1,754	\$497	\$497	\$994	
Distributed Road Management         \$0 <t< td=""><td>TMS17</td><td>Traffic Maintenance</td><td>\$20</td><td>\$20</td><td>\$60</td><td>\$30</td><td>\$30</td><td>\$180</td><td></td></t<>	TMS17	Traffic Maintenance	\$20	\$20	\$60	\$30	\$30	\$180	
TMC Advanced Signal Control         \$0         \$415         \$0         \$608         \$608           TMC Regional Traffic Control         \$364         \$0         \$724         \$205         \$409         \$409           TMC based Freeway Control         \$0         \$196         \$586         \$0         \$409         \$460           TMC based Freeway Control         \$0         \$0         \$0         \$0         \$0         \$0         \$0           TMC based Freeway Control         \$0<	TMS2	Distributed Road Management	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Regional Traffic Control         \$364         \$0         \$724         \$205         \$409           TMC based Freeway Control         \$0         \$196         \$586         \$0         \$40           TMC based Freeway Control         \$0         \$0         \$0         \$0         \$0           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0           TMC for AHS         TMC for AHS         \$0         \$0         \$0         \$0           TMC HOV/Reversible Lane Management         \$0         \$231         \$557         \$0         \$0           TMC Incident Detection         \$0         \$230         \$121         \$124         \$1290           Fleet Maintenance Management         \$0         \$241         \$121         \$0         \$12	TMS3	TMC Advanced Signal Control	\$0	\$0	\$415	\$0	\$0	\$608	
TMC based Freeway Control         \$0         \$196         \$586         \$0         \$230         \$460           TMC Basic Signal Control         \$0	TMS4	TMC Regional Traffic Control	\$364	\$0	\$724	\$205	\$205	\$409	
TMC Basic Signal Control         \$0         \$	TMS5	TMC based Freeway Control	\$0	\$196	\$586	\$0	\$230	\$460	
TMC for AHS         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$124         \$0         \$124         \$124         \$124         \$124         \$1290         \$1290         \$120	TMS6	TMC Basic Signal Control	\$0	\$0	\$0	\$0	\$0	\$0	
TMC HOV/Reversible Lane Management         \$0         \$231         \$557         \$0         \$107         \$214           TMC Incident Detection         \$0         \$302         \$727         \$0         \$645         \$1,290           Fleet Maintenance Management         \$0         \$241         \$121         \$0         \$14         \$22           FIGURE 6.3.2 THRIVILLE SUMMARY EQUIRAMARY EQUIPMENT DAVISOR EXPENDITURES EXPENDITURES CORPUGATION         \$231         \$22         \$22	TMS7	TMC for AHS	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Incident Detection         \$0         \$302         \$727         \$0         \$645         \$1,290           Fleet Maintenance Management         \$0         \$241         \$121         \$0         \$14         \$22           Fleet Maintenance Management         \$0         \$241         \$121         \$0         \$14         \$22	TMS8	TMC HOV/Reversible Lane Management	\$0	\$231	\$557	\$0	\$107	\$214	
Fleet Maintenance Management \$0 \$241 \$121 \$0 \$14 \$22 \$	6SWL	TMC Incident Detection	\$0	\$302	\$727	\$0	\$645	\$1,290	
	TRM1	Fleet Maintenance Management	\$0	\$241	\$121	\$0	\$14	\$22	
		CANCAGE THE STATE OF THE STATE			NO. F.				106

	Equipment Packa	ackage Expenditures for High Market Penetration	es for High I	Narket Penet	ration			
		Non-Rec	Non-Recurring Expenditures	ditures	Recurri	Recurring Expenditures	ures	
		Yrs	Yrs	Yrs	Average A	<b>Average Annual Expenditures</b>	nditures	
EP ID	Equipment Package Name	1-5	6-10	11-20	2	10	20	
TRM2	Transit Center Fare and Load Management	\$	\$583	\$292	\$0	\$14	\$20	
TRM3	Transit Center Fixed-Route Operations	\$497	\$249	\$0	\$462	\$694	\$694	
TRM4	Transit Center Multi-Modal Coordination	\$0	\$	\$0	\$	\$0	\$0	
TRM5	Transit Center Paratransit Operations	\$280	\$140	\$0	\$2	\$2	\$2	
TRM6	Transit Center Security	\$0	\$641	\$461	\$0	\$409	\$614	
TRM7	Transit Center Tracking and Dispatch	\$847	\$1,694	\$45	\$267	\$802	\$802	
TRV1	On-board Maintenance	\$265	\$276	\$929	\$131	\$417	\$461	
TRV2	On-board Transit Driver I/F	\$1,779	\$1,134	\$3,380	\$395	\$629	\$69\$	
TRV3	On-board Transit Fare and Load Management	\$469	\$278	\$826	\$551	\$878	\$970	
TRV4	On-board Transit Security	\$804	\$1,751	\$2,821	\$76	\$243	\$268	
TRV5	On-board Vehicle Signal Coordination	\$0	\$390	\$654	\$0	\$12	\$21	
TRV6	Vehicle Dispatch Support	\$0	\$0	\$0	\$35	\$112	\$124	
TRV7	On-board Trip Monitoring	\$332	\$197	\$585	\$523	\$834	\$921	
VS1	Basic Vehicle Reception	\$5,108	\$13,448	\$107,605	\$0	\$0	\$0	
VS10	Vehicle Lateral Control	\$0	\$0	\$0	\$0	\$0	\$0	
VS11	Vehicle Lateral Warning System	\$0	\$6,495	\$53,811	\$0	\$186	\$1,537	
VS12	Vehicle Longitudinal Control	\$0	\$2,783	\$23,062	\$0	\$186	\$1,537	
VS13	Vehicle Longitudinal Warning System	\$298	\$62,271	\$173,106	83	\$1,788	\$4,937	
VS14	Vehicle Mayday I/F	\$10,641	\$24,151	\$87,514	\$5,533	\$18,092	\$39,974	
VS15	Vehicle Pre-Crash Safety Systems	\$0	\$0	\$56,374	\$0	\$0	\$2,050	
VS16	Vehicle Route Guidance	\$6,810	\$45,145	\$252,804	\$2,894	\$22,081	\$104,547	
VS17	Vehicle Safety Monitoring System	\$4,427	\$43,818	\$137,673	\$341	\$3,711	\$10,250	
VS18	Vehicle Systems for AHS	\$0	\$0	\$10,763	\$0	\$0	\$308	
VS19	Vehicle Toll/Parking I/F	\$1,022	\$2,690	\$21,521	\$0	\$0	\$0	
VS2	Driver Safety Monitoring System	\$0	\$19,947	\$110,184	\$0	\$1,392	\$7,687	
VS3	Driver Visibility Improvement System	\$0	\$0	\$61,499	\$0	\$0	\$3,075	
VS4	In-Vehicle Signing System	\$0	\$7,422	\$32,799	\$0	\$464	\$2,050	
AS5	Interactive Vehicle Reception	\$851	\$8,427	\$21,351	\$511	\$5,567	\$12,300	
NS6	Probe Vehicle Software	\$0	\$928	\$2,562	\$0	\$186	\$512	
VS7	Smart Probe	\$0	\$0	\$0	\$0	\$0	\$0	
NS8	Vehicle Intersection Collision Warning	\$0	\$0	\$0	\$0	\$0	\$0	
VS9	Vehicle Intersection Control	\$0	\$0	\$0	\$0	\$0	\$0	
	FIGURE 6:3-2 I HRUVILLE SUMMARY EQUIPMEN I PACKA	PACKAGE EXPENDI URES FOR HIGH MARKET PENEL RATION	OR HIGH MARKEI	PENEIRATION				197

	Equipment Package	kage Expenditures for High Market Penetration	s for High M	arket Penetr	ation		
g	Government Stakeholder	Non-Recu	Non-Recurring Expenditures	ditures	Recurr	Recurring Expenditures	ures
		Yrs	Yrs	Yrs	Average A	Average Annual Expenditures	nditures
Subsystem	Subsystem Name	1-5	6-10	11-20	5	10	20
CVAS	Commmercial Vehicle Administration Subsystem	\$676	\$1	\$32	\$716	\$716	\$716
CVCS	Commercial Vehicle Check Subsystem	\$809	\$6	\$202	\$27	\$27	\$27
EMS	Emergency Management Subsystem	\$203	\$203	\$393	\$147	\$295	\$295
EMMS	Environmental And Emmisions Management Subsystem	\$0	\$1	\$0	\$0	\$107	\$107
EVS	Emergency Vehicle Subsystem	\$895	\$2,321	\$5,380	\$170	\$612	\$1,025
PMS	Parking Management Subsystem	\$172	\$231	\$905	\$290	\$652	\$1,629
PS	Planning Subsystem	\$0	\$35	\$35	\$0	\$450	\$450
RS	Roadside Subsystem	\$6,648	\$92,638	\$89,690	\$223	\$5,268	\$8,194
RTS	Remote Traveler Subsystem	\$520	\$1,261	\$5,750	\$86	\$409	\$1,392
TAS	Toll Administration Subsystem	\$26	\$10	\$60	\$49	\$49	\$49
TCS	Toll Collection Subsystem	\$450	\$0	\$240	\$110	\$110	\$110
TMS	Traffic Management Subsystem	\$2,273	\$1,313	\$6,110	\$1,283	\$2,264	\$5,137
TRMS	Transit Management Subsystem	\$1,624	\$3,548	\$918	\$731	\$1,935	\$2,154
TRVS	Transit Vehicle Subsystem	\$3,649	\$4,327	\$9,193	\$1,712	\$3,126	\$3,459

Expenditures are in constant 1995 dollars in (1,000's) \$17,974 \$105,894 \$118,907 \$5,545 \$16,021 \$24,744

FIGURE 6.3-3 THRUVILLE SUMMARY GOVERNMENT ONLY EXPENDITURES FOR HIGH MARKET PENETRATION

### 7. SAMPLE EXPENDITURE CALCULATIONS - RURAL AREA

The Phase II cost evaluation of the National ITS Architecture includes an evaluation of three separate scenarios. Each scenario represents a typical deployment area and is to provide a frame of reference for similar implementations of the architecture. A high level description of the rural area, Mountainville, is included in the Evaluatory Design Document. A more indepth description of Mountainville is located in the "Rural Scenario Guide, Mountainville, Phase II" scenario description document. The scenario description is a common description utilized for numerous architecture evaluation activities, including: the cost evaluation, the benefit analysis, as well as technical performance analyses. Thus, the results of the various architecture evaluation activities are all based upon one common set of assumptions.

The cost analysis evaluates five, ten and twenty year deployment milestones as specified in the Phase II Deliverable Guidelines

### 7.1 Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the previous sections 4.6.1 through 4.6.19. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and maintenance requirements. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology (often referenced to equipment manufacturers' estimated unit prices for comparable technology and referenced to integration and systems engineering companies' and equipment manufacturers' estimated unit prices for comparable technology.)

The unit price justification is noted in the Common Equipment section of 4.6 and in the worksheets' column for "Comparative Technology." In the worksheets, where "Existing Technology" is noted, the prices represent typical unit prices for equipment found in catalogs, such as Sweet's Engineering and Retrofit, a catalog for construction cost estimating for current, off-the-shelf technology. Other references to price justification indicate specific construction bid prices for recent contracts. These prices are actual bid prices for installation. Where these two forms of justification were not available, some estimations are provided through consultations with experts in respective fields for manufacturing, and system integration. Lastly, some prices which are less certain are estimates based on professional judgement.

### 7.2 Identification and Evaluation of Quantities and Market Size

For the Equipment Package parameters, the quantity of items purchased influences the unit price for the equipment. Obviously, price breaks come into effect when larger quantities are purchased. For existing technology, many equipment prices are at a steady state price (exhibited in the far right columns of the Equipment Worksheets.) The prices are generally not subject to wide fluctuations based on quantities. Newer technology, or services which are

on the front end of a market/product development curve, are subject to wide price ranges. For Mountainville, two sets of market penetrations were analyzed, a high and a low scenario. For the cost evaluation activities the low value of the unit price ranges was utilized for all Equipment Packages.

### 7.3 Calculation of Expenditures

Expenditures are calculated automatically through the linked spreadsheet programs. Included in the calculation are non-recurring expenditures (one-time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred in accordance with the Evaluatory Design Document deployment quantities for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the expenditures for asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets. This tabulation of non-recurring expenditures continues from the year of initial deployment through the analysis time frame. This evaluation is important when considering comparative technologies and life cycle costs (see previous section on life cycle costing.)

### 7.4 Results

Similar to the results from the Urbansville analysis, tabulated below are the non-recurring and recurring expenditures for a minimal basic service a mid-range service, and a comprehensive service, that would be experienced by one individual in the individual consumers group. As stated in section 4.6.19, the unit price of equipment for in-vehicle devices are based on existing technology, or nationally developed technology which takes advantage of national market deployment price breaks.

Basic service provides the capability for drivers to interface with the ISP Subsystem's Basic Information Broadcast Equipment Package, receive formatted traffic advisories including accurate traveling information concerning available travel options, their availability, and congestion information in their vehicle. Basic Service also provides Vehicle MAYDAY service. Mid-range Service provides the Basic services plus In-Vehicle hardware, and software for Vehicle Route Guidance and Interactive Vehicle Reception. The comprehensive Service provides the Basic and Mid-range Services plus equipment for In-Vehicle Signing, Probe Vehicle Software, Smart Probe, and Vehicle Route Guidance.

### INDIVIDUAL NON-RECURRING EXPENDITURES

Basic Service	VS1, VS14	\$450
Mid-range Service	Basic+VS5,VS16	\$1,350
Comprehensive Service	Mid-Range+VS4,VS6,VS7, VS19	\$2,140

If all vehicle Equipment Packages including safety systems are combined, the total per vehicle non-recurring expenditure is \$8,310.

### INDIVIDUAL MONTHLY RECURRING EXPENDITURES

	C	<b>Operation</b>	Maintenance
Basic Service	VS1, VS14	\$10	\$1
Mid-range Service	Basic+VS5,V16	\$35	<\$5
Comprehensive Service	Mid-Range+VS4,VS6,VS7, VS	\$19 \$35	<\$8

The monthly service charges for in-vehicle services are in the range of \$0 to \$43 per month for individual users (based on average usage) and are comparable to current service cost experiences for cellular telephone service.

Scenario expenditures for Mountainville are classified into likely stakeholder responsibility for funding. The resulting allocations are presented below.

### Mountainville High Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	36%
Commercial	18%
Individual	46%

### Mountainville Low Market Penetration Twenty Year Non-Recurring Expenditure Totals

	Percent of Total
Stakeholder	Funding Requirements
Government	54%
Commercial	18%
Individual	28%

The summary expenditures for the Mountainville Equipment Packages are provided in the following pages. The non-recurring expenditures are tabulated below for the deployment milestone in the evaluation period. Note that the summations consists of the expenditures for the year stated plus the expenditures for the four previous years. The numbers presented for the recurring expenditures represent the expenditures for operation and maintenance during the deployment milestone years. Note that the non-recurring expenditures include replacement expenditures for reinvestment of equipment at the end of its' useful life.

The first of the analysis results, are for a low level market penetration, consistent with the evaluatory design parameters for deployment penetration. The second set of results are for the high level market penetration. The last results page is reflective of the government expenditures.

	Equipment Package	Expenditu	res for L	ow Marke	<b>Expenditures for Low Market Penetration</b>	on		
		Non-Recu	Non-Recurring Expenditures	ditures	Recurrin	Recurring Expenditures	Ires	
		Yrs	Yrs	Yrs	Average An	Average Annual Expenditures	ditures	
EP ID	Equipment Package Name	1-5	6-10	11-20	2	10	20	
CVA1	Credentials and Taxes Administration	\$277	\$1	\$16	\$281	\$281	\$281	
CVA2	CV Information Exchange	\$22	\$0	\$0	\$77	\$77	\$77	
CVA3	CV Safety Administration	\$40	\$0	\$0	\$0	\$0	\$0	
CVA4	International CV Administration	\$0	\$0	\$0	\$0	\$0	\$0	
CVC1	Citation and Accident Electronic Recording	\$20	\$0	\$0	\$2	\$2	\$2	
CVC2	International Border Crossing	\$0	\$0	\$0	\$0	\$0	\$0	
CVC3	Roadside Electronic Screening	\$326	\$0	\$80	6\$	6\$	6\$	
CVC4	Roadside Safety Inspection	\$44	\$3	\$6	\$2	\$2	\$2	
CVC5	Roadside WIM	\$15	\$0	\$15	\$1	\$1	\$1	
CVS1	On-board Cargo Monitoring	\$0	\$1	\$4	\$0	\$2	\$10	
CVS2	On-board CV Electronic Data	\$0	\$3	\$12	\$0	\$1	\$4	
CVS3	On-board CV Safety	\$0	\$3	\$11	\$0	\$0	\$0	
CVS4	On-board Trip Monitoring	\$20	\$19	\$524	\$2	\$12	\$66	
EM1	Emergency and Incident Management Communication	\$0	\$0	\$6	\$0	\$0	\$7	
EM2	Emergency Mayday and E-911 I/F	\$0	\$105	\$105	\$0	\$2	\$2	
EM3	Emergency Response Management	\$0	\$0	\$91	\$0	\$0	\$136	
EM4	Emergency Vehicle Routing and communications	\$	\$0	\$1	\$0	\$0	\$1	
EMM1	Emissions and Environmental Data Management	\$0	\$1	\$0	\$0	\$54	\$54	
EVS1	On-board EV Incident Management Communication	\$1	\$1	6\$	\$0	\$0	\$2	
EVS2	On-board Vehicle Signal Coordination	\$1	\$1	\$\$	\$0	\$0	\$2	
FMS1	Fleet Administration	\$0	\$356	\$2	\$0	\$2	\$2	
FMS2	Fleet Credentials and Taxes Management and Reporting	\$	\$311	\$31	\$0	\$342	\$342	
FMS3	Fleet HAZMAT Management	\$0	\$0	\$0	\$0	\$0	\$0	
FMS4	Freight Administration and Management	\$	\$2	\$2	\$0	\$1	\$1	
FMS5	Fleet Maintenance Management	\$0	\$121	\$0	\$0	2\$	\$7	
ISP1	Basic Information Broadcast	\$0	\$0	\$422	\$0	\$0	\$316	
ISP2	EM Route Plan Information Dissemination	\$0	\$0	\$0	\$0	\$0	\$0	
ISP3	Infrastructure Provided Dynamic Ridesharing	\$0	\$0	\$0	\$0	\$0	\$0	
ISP4	Infrastructure Provided Route Selection	\$0	\$0	\$0	\$0	\$0	\$0	
ISP5	Infrastructure Provided Yellow Pages & Reservation	\$0	\$0	\$0	\$0	\$0	\$0	
ISP6	Interactive Infrastructure Information	\$0	\$0	\$329	\$0	\$0	\$118	
ISP7	ISP Advanced Integrated Control Support	\$0	\$0	\$0	\$0	\$0	\$0	
ISP8	ISP Probe Information Collection	\$0	\$0	\$0	\$0	\$0	\$0	
PIA1	Personal Basic Information Reception	\$0	\$0	\$13	\$0	\$0	\$3	
PIA2	Personal Interactive Information Reception	\$0	\$1	2\$	\$0	\$1	\$2	
PIA3	Personal Mayday I/F	\$0	\$47	\$198	\$0	\$8	\$34	
PIA4	Personal Route Guidance	\$0	\$0	\$17	\$0	\$0	\$2	
PMS1	Parking Management	\$0	\$0	\$0	\$0	\$0	\$0	
PS1	Data Collection and ITS Planning	\$	\$0	\$0	\$0	\$0	\$0	
	FIGURE 7.3-1 MOUNTAINVILLE SUMMARY EQUIPMENT PACKAGE EXPENDITURES FOR LOW MARKET PENETRATION	PACKAGE EXPEN	DITURES FOR LOV	V MARKET PENETR	ATION			203

	Equipment Package I	Expenditu	res for L	ow Marke	<b>Expenditures for Low Market Penetration</b>	on		
		Non-Recu	Non-Recurring Expenditures	ditures	Recurrin	Recurring Expenditures	ures	
		Yrs	Yrs	Yrs	Average An	<b>Average Annual Expenditures</b>	ditures	
EP ID	Equipment Package Name	1-5	6-10	11-20	5	10	20	
RS1	Automated road signing	\$0	\$125	\$375	\$0	\$13	\$25	
RS10	Roadway Pollution and Environmental Hazards Indicators	\$0	\$208	\$334	\$0	\$1	\$2	
RS11	Roadway Probe Beacons	\$0	\$125	\$375	\$0	\$13	\$25	
RS12	Roadway Reversible Lanes	\$	\$0	\$0	\$0	\$0	\$0	
RS13	Roadway Systems for AHS	\$0	\$0	\$0	\$0	\$0	\$0	
RS14	Roadway Traffic Information Dissemination	\$0	\$426	\$18	\$0	\$14	\$14	
RS2	Roadside Signal Priority	\$0	\$0	\$0	\$0	\$0	\$0	
RS3	Roadway Freeway Control	\$0	\$0	\$0	\$0	\$0	\$0	
RS4	Roadway Signal Controls	\$0	\$0	\$0	\$0	\$0	\$0	
RS5	Roadway Basic Surveillance	\$0	\$0	\$0	\$0	\$0	\$0	
RS6	Roadway HOV Usage	\$0	\$0	\$0	\$0	\$0	\$0	
RS7	Roadway In-Vehicle Signing	\$0	\$160	\$420	\$0	\$10	\$20	
RS8	Roadway Incident Detection	\$0	\$0	\$0	\$0	\$0	\$0	
RS9	Roadway Intersection Collision System	\$0	\$0	\$0	\$0	\$0	\$0	
RTS1	Remote Interactive Information Reception	\$0	\$0	\$0	\$0	\$0	\$0	
RTS2	Remote Mayday I/F	\$0	\$0	\$0	\$0	\$0	\$0	
RTS3	Remote Transit Fare Management	\$	\$0	\$0	\$0	\$	\$0	
RTS4	Remote Transit Security I/F	\$0	\$0	\$0	\$0	\$0	\$0	
RTS5	Remote Basic Information Reception	\$	\$0	\$0	\$0	\$0	\$0	
TAS1	Toll Administration	\$0	\$0	\$0	\$0	\$0	\$0	
TCS1	Toll Plaza Toll Collection	\$0	\$0	\$0	\$0	\$0	\$0	
TMS1	Collect Traffic Surveillance	\$0	\$0	\$0	\$0	\$0	\$0	
TMS10	TMC Incident Dispatch Coordination/Communication	\$	\$199	\$78	\$0	\$92	\$92	
TMS11	TMC Input to In-Vehicle Signing	\$0	\$0	\$0	\$0	\$0	\$0	
TMS12	TMC Multi-Modal Coordination	\$0	\$0	\$0	\$0	\$0	\$0	
TMS13	TMC Probe Information Collection	\$0	\$0	\$0	\$0	\$0	\$0	
TMS14	TMC Toll/Parking Coordination	\$0	\$0	\$0	\$0	\$0	\$0	
TMS15	TMC Traffic Information Dissemination	\$0	\$117	\$46	\$0	\$120	\$120	
TMS16	TMC Traffic Network Performance Evaluation	\$0	\$0	\$0	\$0	\$0	\$0	
TMS17	Traffic Maintenance	\$0	\$0	\$0	\$0	\$0	\$0	
TMS2	Distributed Road Management	\$0	\$364	\$360	\$0	\$205	\$205	
TMS3	TMC Advanced Signal Control	0\$	\$0	\$0	\$0	\$	\$0	
TMS4	TMC Regional Traffic Control	\$	\$0	\$0	\$0	\$0	\$0	
TMS5	TMC based Freeway Control	\$	\$0	\$0	\$0	\$0	\$0	
TMS6	TMC Basic Signal Control	\$0	\$0	\$0	\$0	\$0	\$0	
TMS7	TMC for AHS	\$0	\$0	\$0	\$0	\$0	\$0	
TMS8	TMC HOV/Reversible Lane Management	\$0	\$0	\$0	\$0	\$0	\$0	
6SMT	TMC Incident Detection	\$0	\$0	\$0	\$0	\$0	\$0	
TRM1	Fleet Maintenance Management	\$0	\$0	\$121	\$0	\$0	2\$	
	FIGURE 7.3-1 MOUNTAINVILLE SUMMARY EQUIPMENT PACKAGE EXPENDITURES FOR LOW MARKET PENETRATION	PACKAGE EXPENI	DITURES FOR LOV	V MARKET PENETR	ATION			204

	Equipment Package	EAPCITUITIES TO FOW INDIVEL FOILCHAIDIN			5 ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;			
		Non-Rect	Non-Recurring Expenditures	nditures	Recurri	Recurring Expenditures	ures	
		Yrs	Yrs	Yrs	Average A	Annual Expenditures	nditures	
EP ID	Equipment Package Name	1-5	6-10	11-20	2	10	20	
TRM2	Transit Center Fare and Load Management	\$	\$0	\$292	0\$	\$0	2\$	
TRM3	Transit Center Fixed-Route Operations	\$	\$0	\$249	\$0	\$0	\$231	
TRM4	Transit Center Multi-Modal Coordination	0\$	\$0	\$0	\$0	\$0	\$0	
TRM5	Transit Center Paratransit Operations	0\$	\$0	\$140	\$0	\$0	\$1	
TRM6	Transit Center Security	0\$	\$0	\$321	\$0	\$0	\$205	
TRM7	Transit Center Tracking and Dispatch	0\$	\$847	\$15	\$0	\$267	\$267	
TRV1	On-board Maintenance	0\$	6\$	\$15	\$0	\$2	2\$	
TRV2	On-board Transit Driver I/F	0\$	\$0	\$20	\$0	\$0	\$11	
TRV3	On-board Transit Fare and Load Management	0\$	\$0	\$13	\$0	\$0	\$16	
TRV4	On-board Transit Security	0\$	\$0	\$45	\$0	\$0	\$4	
TRV5	On-board Vehicle Signal Coordination	\$	\$0	\$0	\$0	\$0	\$0	
TRV6	Vehicle Dispatch Support	\$	\$0	\$0	\$0	\$0	\$2	
TRV7	On-board Trip Monitoring	\$	\$0	\$	\$0	\$0	\$15	
VS1	Basic Vehicle Reception	\$15	\$60	\$407	\$0	\$0	\$0	
VS10	Vehicle Lateral Control	\$0	\$0	\$0	\$0	\$0	\$0	
VS11	Vehicle Lateral Warning System	\$	\$0	\$138	\$0	\$0	\$	
VS12	Vehicle Longitudinal Control	\$0	\$0	\$29	\$0	\$0	\$4	
VS13	Vehicle Longitudinal Warning System	\$0	\$26	\$138	\$0	\$1	\$	
VS14	Vehicle Mayday I/F	\$55	\$6\$	\$349	\$28	\$78	\$153	
VS15	Vehicle Pre-Crash Safety Systems	0\$	\$0	\$87	\$0	\$0	\$3	
VS16	Vehicle Route Guidance	\$	\$60	\$440	\$0	\$26	\$187	
VS17	Vehicle Safety Monitoring System	\$19	\$78	\$529	\$1	\$7	\$39	
VS18	Vehicle Systems for AHS	\$	\$0	\$0	\$0	\$0	\$0	
VS19	Vehicle Toll/Parking I/F	\$	\$0	\$0	\$0	\$0	\$0	
VS2	Driver Safety Monitoring System	\$0	\$32	\$338	\$0	\$2	\$24	
VS3	Driver Visibility Improvement System	\$0	\$0	\$95	\$0	\$0	\$5	
VS4	In-Vehicle Signing System	\$0	\$12	\$126	\$0	\$1	\$\$	
VS5	Interactive Vehicle Reception	\$0	\$22	\$55	\$0	\$13	\$33	
VS6	Probe Vehicle Software	\$0	\$0	\$4	\$0	\$0	\$1	
VS7	Smart Probe	\$0	\$4	\$43	\$0	\$0	\$1	
VS8	Vehicle Intersection Collision Warning	\$0	\$0	\$0	\$0	\$0	\$0	
VS9	Vehicle Intersection Control	\$0	\$0	\$0	\$0	\$0	\$0	
	FIGURE 7.3-1 MOUNTAINVILLE SUMMARY EQUIPMEN	QUIPMENT PACKAGE EXPENDITURES FOR LOW MARKET PENETRATION	DITURES FOR LO	V MARKET PENETF	RATION			205

EP ID         Equipment Package Name         17s         +17s         Average Annual Expenditures           CVA7         Covad Covernies and Local Administration         17s         +10         5         10         20           CVA7         Covad Covernies and Local Administration         5277         51         51         5281         5281           CVA3         CVI Conservation and Local Administration         527         52         50         50         50           CVA3         CVI Conservation and Conservation		Equipment Package	Expenditures for High Market Penetration	es for High	Market Pe	netration			
Concenting and functional processing and functi			Non-Rect	urring Expen	ditures	Recurri	ng Expendit	ures	
Conceius and frace Administration   1-5   6-10   11-20   5-5   10-5			Yrs	Yrs	Yrs	Average A	nnual Expen	ditures	
Overletination of Configuration of	EP ID	Equipment Package Name	1-5	6-10	11-20	22	10	20	
OV SIMPLY Administration         SAZZ         SAZ         SAZ <td>CVA1</td> <td>Credentials and Taxes Administration</td> <td>\$277</td> <td>\$1</td> <td>\$16</td> <td>\$281</td> <td>\$281</td> <td>\$281</td> <td></td>	CVA1	Credentials and Taxes Administration	\$277	\$1	\$16	\$281	\$281	\$281	
No.   State   Communication   State	CVA2	CV Information Exchange	\$22	\$0	\$0	\$77	\$77	\$77	
Internation and Actioner Recording   \$50   \$60   \$50	CVA3	CV Safety Administration	\$40	\$0	\$0	\$0	\$0	\$0	
International Boarder Chestoring   S20   S90	CVA4	International CV Administration	\$0	\$0	\$0	\$0	\$0	\$0	
Principation algorithm and the Administration algorithm and the Administration algorithm and the Administration algorithm and the Administration and Administration	CVC1	Citation and Accident Electronic Recording	\$20	\$0	\$0	\$2	\$2	\$2	
Accordation Encoronic Screening         \$44         \$53         \$50         \$59         \$50           Accordation Encoronic Screening         \$44         \$51         \$51         \$52         \$52           Accordated Willy Mandeled Montelluring         \$51         \$51         \$51         \$51         \$52         \$52           On-beard Conformation         \$51         \$51         \$50         \$51         \$52         \$50	CVC2	International Border Crossing	\$0	\$0	\$0	\$0	\$0	\$0	
Repaired by Management Cargo Montering         \$14         \$2         \$6         \$7 <td>CVC3</td> <td>Roadside Electronic Screening</td> <td>\$326</td> <td>\$0</td> <td>\$80</td> <td>\$</td> <td>6\$</td> <td>\$6</td> <td></td>	CVC3	Roadside Electronic Screening	\$326	\$0	\$80	\$	6\$	\$6	
Production Working with Communication   St   St   St   St   St   St   St   S	CVC4	Roadside Safety Inspection	\$44	\$3	\$6	\$2	\$2	\$2	
On-board Cyz Betynning         \$1         \$1         \$29         \$22         \$20           On-board Cyz Betynning         \$1         \$1         \$24         \$27         \$5         \$5           On-board Cyz Betynning         \$1         \$1         \$1         \$5         \$5         \$5           On-board Cyz Betynning         \$1         \$1         \$1         \$5         \$5         \$5           Emergency Mayday and E-9f1 IF         \$10         \$5         \$1         \$7         \$7         \$7           Emergency Mayday and E-9f1 IF         \$10         \$5         \$1	CVC5	Roadside WIM	\$15	\$0	\$15	\$1	\$1	\$1	
On-board VC Relevonic Data         \$1         \$4         \$10         \$6         \$10         \$6         \$10         \$6         \$10         \$6         \$10	CVS1	On-board Cargo Monitoring	\$1	\$1	6\$	\$2	\$2	\$23	
On-board VC saffey         \$1         \$4         \$15         \$6         \$50         \$60	CVS2	On-board CV Electronic Data	\$1	\$	\$20	\$0	\$1	\$6	
Chropard Tip Monitoring	CVS3	On-board CV Safety	\$1	\$4	\$17	\$0	\$0	\$0	
Energetory and Incident Management Communication         \$6         \$0         \$17         \$7         \$7           Energetory Management Communications         \$10         \$0         \$105         \$2         \$5           Energetory Management Communications         \$1         \$0         \$13         \$1         \$1           Energetory Vehicle Routing and communications         \$1         \$6         \$1         \$1         \$1           Energetory Vehicle Routing and communication         \$1         \$6         \$1         \$2         \$1         \$1           Ch-board Vehicle Signal Coordination         \$1         \$1         \$2         \$0         \$1         \$2           On-board Vehicle Signal Coordination         \$1         \$1         \$2         \$0         \$1         \$2           On-board Vehicle Signal Coordination         \$1         \$1         \$2         \$2         \$1         \$2         \$1         \$1         \$2           On-board Vehicle Signal Coordination         \$1         \$1         \$1         \$2         \$2         \$1         \$2         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$1         \$2         \$1         \$1	CVS4	On-board Trip Monitoring	\$49	\$151	\$839	\$6	\$25	\$105	
Emergency Mayday and E-911 I/F         \$105         \$105         \$22         \$2           Emergency Mayday and E-911 I/F         \$11         \$1         \$136         \$136         \$136           Emergency Vales Resource And Amanagement         \$1         \$0         \$1         \$1         \$1         \$1         \$1           Emissions and Environmental Data Management         \$1         \$2         \$2         \$2         \$2         \$1 <td< td=""><td>EM1</td><td>Emergency and Incident Management Communication</td><td>\$6</td><td>\$0</td><td>\$1</td><td>\$7</td><td>\$2</td><td>\$2</td><td></td></td<>	EM1	Emergency and Incident Management Communication	\$6	\$0	\$1	\$7	\$2	\$2	
Emergency Response Management         \$91         \$90         \$136         \$136           Emergency Alexagement of Management and Percental Data Management Communication         \$1         \$0         \$1	EM2	Emergency Mayday and E-911 I/F	\$105	\$0	\$105	\$2	\$2	\$2	
Emergency Vehicle Routing and communications         \$1         \$	EM3	Emergency Response Management	\$91	\$0	06\$	\$136	\$136	\$136	
Price   Pric	EM4	Emergency Vehicle Routing and communications	\$1	\$0	\$1	\$1	\$1	\$1	
On-board ( Vehicle roll Management Communication)         \$1         \$5         \$9         \$0         \$1         \$2           On-board ( Vehicle roll Management Communication)         \$356         \$1         \$333         \$5         \$1         \$2           Fleet Administration         Fleet Administration         \$314         \$342         \$342         \$56         \$1         \$6           Fleet HAZMAT Management         \$0         \$0         \$422         \$0	EMM1	Emissions and Environmental Data Management	\$0	\$1	\$0	\$0	\$54	\$54	
Peret Administration	EVS1	On-board EV Incident Management Communication	\$1	\$2	6\$	\$0	\$1	\$2	
Fleet Administration	EVS2	On-board Vehicle Signal Coordination	\$1	\$4	\$8	\$0	\$1	\$2	
Fleet Credentials and Taxes Management and Reporting	FMS1	Fleet Administration	\$326	\$1	\$363	\$2	\$2	\$10	
Fleet HAZMAT Management         \$0         \$0         \$0         \$0         \$0           Freight Administration and Management         \$12         \$0         \$12         \$1         \$2           Freight Administration and Management         \$121         \$0         \$121         \$7         \$14           Basic Information Basic Information Dissemination         \$0         \$0         \$0         \$0         \$0         \$0           EM Route Plan Information Dissemination         \$0 <td>FMS2</td> <td>Fleet Credentials and Taxes Management and Reporting</td> <td>\$311</td> <td>\$16</td> <td>\$342</td> <td>\$342</td> <td>\$342</td> <td>\$684</td> <td></td>	FMS2	Fleet Credentials and Taxes Management and Reporting	\$311	\$16	\$342	\$342	\$342	\$684	
Freight Administration and Management         \$121         \$1         \$1         \$2           Fleet Maintenance Management         \$121         \$0         \$121         \$7         \$14           Fleet Maintenance Management         \$121         \$0         \$121         \$7         \$14           East Information Broadcast         \$0         \$0         \$0         \$0         \$0         \$0           EM Route Plan Information Dissemination         \$0         \$0         \$0         \$0         \$0         \$0           Infrastructure Provided Dynamic Relection         \$0	FMS3	Fleet HAZMAT Management	\$0	\$0	\$0	\$0	\$0	\$0	
Friett Maintenance Management	FMS4	Freight Administration and Management	\$2	\$0	\$4	\$1	\$1	\$2	
Basic Information Broadcast         \$0         \$422         \$0         \$316           EM Route Plan Information Dissemination         \$0 <t< td=""><td>FMS5</td><td>Fleet Maintenance Management</td><td>\$121</td><td>\$0</td><td>\$121</td><td>2\$</td><td>2\$</td><td>\$14</td><td></td></t<>	FMS5	Fleet Maintenance Management	\$121	\$0	\$121	2\$	2\$	\$14	
EM Route Plan Information Dissemination         \$0 <td>ISP1</td> <td>Basic Information Broadcast</td> <td>\$0</td> <td>\$0</td> <td>\$422</td> <td>\$0</td> <td>\$0</td> <td>\$316</td> <td></td>	ISP1	Basic Information Broadcast	\$0	\$0	\$422	\$0	\$0	\$316	
Infrastructure Provided Dynamic Ridesharing         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$13         \$0         \$13         \$0         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$13         \$14         \$	ISP2	EM Route Plan Information Dissemination	\$0	\$0	\$0	\$0	\$0	\$0	
Infrastructure Provided Route Selection         \$0         \$350         \$0         \$13           Infrastructure Provided Yellow Pages & Reservation         \$0         \$0         \$0         \$0         \$0         \$0           Intracticture Provided Yellow Pages & Reservation         \$0	ISP3	Infrastructure Provided Dynamic Ridesharing	\$0	\$0	\$0	\$0	\$0	\$0	
Interactive Infrastructure Provided Yellow Pages & Reservation         \$0         \$0         \$0         \$0         \$0         \$0         \$118         \$0         \$118 <th< td=""><td>ISP4</td><td>Infrastructure Provided Route Selection</td><td>\$0</td><td>\$0</td><td>\$320</td><td>\$0</td><td>\$0</td><td>\$13</td><td></td></th<>	ISP4	Infrastructure Provided Route Selection	\$0	\$0	\$320	\$0	\$0	\$13	
Interactive Infrastructure Information         \$0         \$0         \$0         \$0         \$118           ISP Advanced Integrated Control Support         \$0	ISP5	Infrastructure Provided Yellow Pages & Reservation	\$0	\$0	\$0	\$0	\$0	\$0	
ISP Advanced Integrated Control Support         \$0 <td>ISP6</td> <td>Interactive Infrastructure Information</td> <td>\$0</td> <td>\$0</td> <td>\$329</td> <td>\$0</td> <td>\$0</td> <td>\$118</td> <td></td>	ISP6	Interactive Infrastructure Information	\$0	\$0	\$329	\$0	\$0	\$118	
ISP Probe Information Collection         \$0	ISP7	ISP Advanced Integrated Control Support	\$0	\$0	\$0	\$0	\$0	\$0	
Personal Basic Information Reception         \$7         \$14         \$2         \$4         \$31           Personal Interactive Information Reception         \$0         \$2         \$14         \$0         \$1         \$10           Personal Interactive Information Reception         \$7         \$86         \$272         \$1         \$16         \$45           Personal Mayday I/F         \$0         \$24         \$16         \$45         \$45           Parking Management         \$0         \$0         \$0         \$0         \$0           Data Collection and ITS Planning         \$0         \$0         \$0         \$0         \$0           Encline 7.3.2 Mol INTARNALLE EXHAMADY EXPLANALLY DAYAGE EXPENDITY DAYAGE DENIET DAYAGE TO BENEFIT DAYAGE T	ISP8	ISP Probe Information Collection	\$0	\$0	\$0	\$0	\$0	\$0	
Personal Interactive Information Reception         \$0         \$1         \$10           Personal Mayday I/F         \$7         \$86         \$272         \$1         \$45           Personal Route Guidance         \$0         \$24         \$168         \$0         \$8         \$54           Parking Management         \$0         \$0         \$0         \$0         \$0         \$0           Data Collection and ITS Planning         \$0         \$0         \$0         \$0         \$0         \$0	PIA1	Personal Basic Information Reception	2\$	\$11	\$140	\$2	\$4	\$31	
Personal Mayday I/F         \$7         \$86         \$272         \$16         \$45           Personal Route Guidance         \$0         \$24         \$168         \$0         \$8         \$54           Parking Management         \$0         \$0         \$0         \$0         \$0         \$0           Data Collection and ITS Planning         \$0         \$0         \$0         \$0         \$0         \$0	PIA2	Personal Interactive Information Reception	\$0	\$2	\$14	\$0	\$1	\$10	
Personal Route Guidance         \$0         \$24         \$168         \$0         \$8         \$54           Parking Management         \$0         \$0         \$0         \$0         \$0         \$0         \$0           Data Collection and ITS Planning         \$0	PIA3	Personal Mayday I/F	\$7	\$86	\$272	\$1	\$16	\$45	
Parking Management         \$0         \$0         \$0         \$0         \$0           Data Collection and ITS Planning         \$0 <t< td=""><td>PIA4</td><td>Personal Route Guidance</td><td>\$0</td><td>\$24</td><td>\$168</td><td>\$0</td><td>\$8</td><td>\$54</td><td></td></t<>	PIA4	Personal Route Guidance	\$0	\$24	\$168	\$0	\$8	\$54	
Data Collection and ITS Planning \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0	PMS1	Parking Management	\$0	\$0	\$0	\$0	\$0	\$0	
	PS1	Data Collection and ITS Planning	\$0	\$0	80	\$0	\$0	\$0	
		A TINEMALI CE VA AMANI SE ELIVINISTINI CANO CE ELEGICIE							300

Page		Equipment Package		<b>Expenditures for High Market Penetration</b>	Market Pe	netration			
Control of			Non-Reci	urring Expen	ditures	Recurri	ng Expendit	ures	
Particular   Package Name   1-5   6-10   11-20   5-1   10   200   10-10   10-20   10-10   10-20   10-10   10-20   10			Yrs	Yrs	Yrs	Average A	nnual Expen	ditures	
		Equipment Package Name	1-5	6-10	11-20	2	10	20	
Rouchway Putlibur met Environmental Hazardis Indications	RS1	Automated road signing	\$0	\$125	\$375	\$0	\$13	\$25	
Readlation System         STORD         STOR         STOR <td>RS10</td> <td>Roadway Pollution and Environmental Hazards Indicators</td> <td>\$0</td> <td>\$208</td> <td>\$334</td> <td>\$0</td> <td>\$1</td> <td>\$2</td> <td></td>	RS10	Roadway Pollution and Environmental Hazards Indicators	\$0	\$208	\$334	\$0	\$1	\$2	
Readway Place Place         SQ         SQ <td>RS11</td> <td>Roadway Probe Beacons</td> <td>\$0</td> <td>\$125</td> <td>\$375</td> <td>\$0</td> <td>\$13</td> <td>\$25</td> <td></td>	RS11	Roadway Probe Beacons	\$0	\$125	\$375	\$0	\$13	\$25	
Readle of Septial Principle         SEPTIAL SERVICE         SEPTIAL SERVICE <t< td=""><td>RS12</td><td>Roadway Reversible Lanes</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td></td></t<>	RS12	Roadway Reversible Lanes	\$0	\$0	\$0	\$0	\$0	\$0	
Reaching Finetine Signal Fronting         S476         \$68         \$61         \$614	RS13	Roadway Systems for AHS	\$0	\$0	\$0	\$0	\$0	\$0	
Recodering Signal Protective         \$6         <	RS14	Roadway Traffic Information Dissemination	\$0	\$476	\$68	\$0	\$14	\$14	
Readway Previote Chrotions   State	RS2	Roadside Signal Priority	\$0	\$0	\$0	\$0	\$0	\$0	
Readway place (activation)         SO         SO <th< td=""><td>RS3</td><td>Roadway Freeway Control</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td></td></th<>	RS3	Roadway Freeway Control	\$0	\$0	\$0	\$0	\$0	\$0	
Readway Hot Visigne         \$0 <td>RS4</td> <td>Roadway Signal Controls</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td></td>	RS4	Roadway Signal Controls	\$0	\$0	\$0	\$0	\$0	\$0	
Readway In-Victorian Displacement	RS5	Roadway Basic Surveillance	\$0	\$0	\$0	\$0	\$0	\$0	
Readway Invalide Signing	RS6	Roadway HOV Usage	\$0	\$0	\$0	\$0	\$0	\$0	
Remote based information Roadway Incident Detection         \$6	RS7	Roadway In-Vehicle Signing	\$0	\$160	\$420	\$0	\$10	\$20	
Reader for Intersection Collision System         \$0 <td>RS8</td> <td>Roadway Incident Detection</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td></td>	RS8	Roadway Incident Detection	\$0	\$0	\$0	\$0	\$0	\$0	
Remote Interactive Information Reception         \$0 <td>RS9</td> <td>Roadway Intersection Collision System</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td></td>	RS9	Roadway Intersection Collision System	\$0	\$0	\$0	\$0	\$0	\$0	
Remote Mayday VF         SC         SO         SO         SO           Remote Mayday VF         Remote Mayday VF         SO         SO         SO         SO           Remote Trasts Seat Management         SO         SO         SO         SO         SO           Remote Basic Information Reception         SO         SO         SO         SO         SO         SO           In In Independent Trastic State Information Reception         SO         SO         SO         SO         SO         SO         SO           In Independent Despetch Coordination         SO	RTS1	Remote Interactive Information Reception	\$0	\$0	\$0	\$0	\$0	\$0	
Remote Transit Fare Management         \$0	RTS2	Remote Mayday I/F	\$0	\$0	\$0	\$0	\$0	\$0	
Remote Transit Security (F)         \$0 <t< td=""><td>RTS3</td><td>Remote Transit Fare Management</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td></td></t<>	RTS3	Remote Transit Fare Management	\$0	\$0	\$0	\$0	\$0	\$0	
Remote Basic Information Reception         \$0	RTS4	Remote Transit Security I/F	\$0	\$0	\$30	\$0	\$0	\$24	
Toll Administration         \$0 <td>RTS5</td> <td>Remote Basic Information Reception</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td></td>	RTS5	Remote Basic Information Reception	\$0	\$0	\$0	\$0	\$0	\$0	
Toll Plaza Toll Collection         \$0 <th< td=""><td>TAS1</td><td>Toll Administration</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td>\$0</td><td></td></th<>	TAS1	Toll Administration	\$0	\$0	\$0	\$0	\$0	\$0	
Collect Traffic Surveillance         \$0         \$0         \$0         \$0         \$0         \$0           TMC Incident Dispatch Coordination/Communication         \$0         \$199         \$78         \$0         \$02         \$02           TMC Incident Dispatch Coordination/Communication         \$0         \$0         \$0         \$0         \$0         \$0         \$0           TMC Multi-Module Incident	TCS1	Toll Plaza Toll Collection	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Incident Dispatch Coordination/Communication         \$0         \$199         \$78         \$92         \$92           TMC Incident Dispatch Coordination         \$0         \$	TMS1	Collect Traffic Surveillance	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Input to In-Vehicle Signing         \$0         \$63         \$0         \$68           TMC Input to In-Vehicle Signing         \$0         \$0         \$0         \$0         \$0           TMC Multi-Modal Coordination         \$0         \$0         \$0         \$0         \$0           TMC Tall/Parking Coordination         \$0         \$0         \$0         \$0         \$0           TMC Tall/Parking Coordination         \$0         \$117         \$46         \$0         \$0         \$0           TMC Tall/Parking Coordination Dissemination         \$0         \$17         \$0<	TMS10	TMC Incident Dispatch Coordination/Communication	\$0	\$199	\$78	<b>%</b>	\$92	\$92	
TMC Multi-Modal Coordination         \$0         \$0         \$0         \$0         \$0           TMC Probe Information Collection         \$0         \$0         \$0         \$0         \$0           TMC Tailford Information Collection         \$0         \$0         \$0         \$0         \$0           TMC Tailfor Information Dissemination         \$0         \$117         \$46         \$0         \$120         \$10           TMC Tailfor Information Dissemination         \$0	TMS11	TMC Input to In-Vehicle Signing	\$0	\$0	\$63	\$0	\$0	\$9\$	
TMC Probe Information Collection         \$0	TMS12	TMC Multi-Modal Coordination	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Toll/Parking Coordination         \$0	TMS13	TMC Probe Information Collection	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Traffic Network Performance Evaluation         \$0         \$117         \$46         \$0         \$120         \$120           TMC Traffic Network Performance Evaluation         \$0         \$0         \$0         \$0         \$0         \$0           Traffic National Control         \$0         \$0         \$0         \$0         \$0         \$0         \$0           Distributed Road Management         \$0	TMS14	TMC Toll/Parking Coordination	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Traffic Network Performance Evaluation         \$0<	TMS15	TMC Traffic Information Dissemination	\$0	\$117	\$46	\$0	\$120	\$120	
Traffic Maintenance         \$0 <td>TMS16</td> <td>TMC Traffic Network Performance Evaluation</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td>\$0</td> <td></td>	TMS16	TMC Traffic Network Performance Evaluation	\$0	\$0	\$0	\$0	\$0	\$0	
Distributed Road Management         \$0         \$364         \$360         \$0         \$205         \$0           TMC Advanced Signal Control         \$0	TMS17	Traffic Maintenance	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Advanced Signal Control         \$0 <t< td=""><td>TMS2</td><td>Distributed Road Management</td><td>\$0</td><td>\$364</td><td>\$360</td><td>\$0</td><td>\$205</td><td>\$205</td><td></td></t<>	TMS2	Distributed Road Management	\$0	\$364	\$360	\$0	\$205	\$205	
TMC Regional Traffic Control         \$0         \$364         \$0         \$205           TMC based Freeway Control         \$0         \$0         \$0         \$0         \$0           TMC based Freeway Control         \$0         \$0         \$0         \$0         \$0           TMC Basic Signal Control         \$0         \$0         \$0         \$0         \$0           TMC for AHS         TMC for AHS         \$0         \$0         \$0         \$0           TMC HOV/Reversible Lane Management         \$0         \$0         \$0         \$0         \$0           TMC Incident Detection         \$0         \$0         \$0         \$0         \$0         \$0           Fleet Maintenance Management         \$0         \$121         \$0         \$0         \$0         \$0           Fleet Maintenance Management         \$0         \$121         \$0         \$0         \$0         \$0	TMS3	TMC Advanced Signal Control	\$0	\$0	\$0	\$0	\$0	\$0	
TMC based Freeway Control         \$0	TMS4	TMC Regional Traffic Control	\$0	\$0	\$364	\$0	\$0	\$205	
TMC Basic Signal Control         \$0         \$	TMS5	TMC based Freeway Control	\$0	\$0	\$0	\$0	\$0	\$0	
TMC for AHS         \$0	TMS6	TMC Basic Signal Control	\$0	\$0	\$0	\$0	\$0	\$0	
TMC HOV/Reversible Lane Management         \$0	TMS7	TMC for AHS	\$0	\$0	\$0	\$0	\$0	\$0	
TMC Incident Detection         \$0<	TMS8	TMC HOV/Reversible Lane Management	\$0	\$0	\$0	\$0	\$0	\$0	
Fleet Maintenance Management \$0 \$121 \$0 \$7 \$7 \$7	EMS9	TMC Incident Detection	\$0	\$0	\$0	\$0	\$0	\$0	
	TRM1	Fleet Maintenance Management	\$0	\$121	\$0	\$0	\$2	\$2	
		CAC TATERDE OF VOICE AND THE CONTRACT OF THE C	- HOW LOW N						700

	Non-Rec	Non-Recurring Expenditures	ditures	Recurri	Recurring Expenditures	ures
	Yrs	Yrs	Yrs	Average A	Annual Expenditures	ditures
EP ID Equipment Package Name	1-5	6-10	11-20	2	10	20
TRM2 Transit Center Fare and Load Management	0\$	\$292	\$0	0\$	2\$	2\$
TRM3 Transit Center Fixed-Route Operations	\$0	\$249	\$0	\$	\$231	\$231
TRM4 Transit Center Multi-Modal Coordination	\$0	\$0	\$0	\$	\$0	\$0
TRM5 Transit Center Paratransit Operations	\$0	\$140	\$0	0\$	\$1	\$1
TRM6 Transit Center Security	\$0	\$321	\$70	\$	\$205	\$205
TRM7 Transit Center Tracking and Dispatch	\$0	\$847	\$15	\$	\$267	\$267
TRV1 On-board Maintenance	\$0	\$15	\$15	\$	\$7	\$7
TRV2 On-board Transit Driver I/F	\$0	\$20	\$54	\$	\$11	\$11
TRV3 On-board Transit Fare and Load Management	\$0	\$13	\$13	\$0	\$16	\$16
TRV4 On-board Transit Security	\$0	\$45	\$45	0\$	\$4	\$4
TRV5 On-board Vehicle Signal Coordination	\$0	\$	\$0	\$	\$0	\$0
TRV6 Vehicle Dispatch Support	\$0	\$0	\$0	\$	\$2	\$2
TRV7 On-board Trip Monitoring	\$0	6\$	6\$	\$	\$15	\$15
VS1 Basic Vehicle Reception	\$44	\$106	\$829	\$0	\$0	\$0
VS10 Vehicle Lateral Control	\$0	\$0	\$0	\$0	\$0	\$0
VS11 Vehicle Lateral Warning System	\$0	\$52	\$412	\$0	\$1	\$12
VS12 Vehicle Longitudinal Control	\$0	\$22	\$177	\$0	\$1	\$12
VS13 Vehicle Longitudinal Warning System	\$2	\$128	\$415	\$0	\$4	\$12
VS14 Vehicle Mayday I/F	\$91	\$189	\$680	\$47	\$146	\$306
VS15 Vehicle Pre-Crash Safety Systems	\$0	\$0	\$432	\$0	\$0	\$16
VS16 Vehicle Route Guidance	\$0	\$119	\$1,885	\$0	\$51	\$801
VS17 Vehicle Safety Monitoring System	\$38	\$351	\$1,059	\$3	\$30	879
VS18 Vehicle Systems for AHS	\$0	\$0	\$0	\$0	\$0	\$0
VS19 Vehicle Toll/Parking I/F	\$0	\$0	\$0	\$0	\$0	\$0
VS2 Driver Safety Monitoring System	\$0	\$160	\$844	\$0	\$11	\$29
VS3 Driver Visibility Improvement System	\$0	\$0	\$472	\$0	\$0	\$24
VS4 In-Vehicle Signing System	\$0	\$60	\$251	\$	\$4	\$16
VS5 Interactive Vehicle Reception	\$0	\$75	\$157	\$0	\$45	\$94
VS6 Probe Vehicle Software	\$0	\$2	\$8	\$0	\$0	\$2
VS7 Smart Probe	\$0	\$16	\$85	\$0	\$0	\$1
VS8 Vehicle Intersection Collision Warning	\$0	\$0	\$0	\$0	\$0	\$0
VS9 Vehicle Intersection Control	80	<b>\$</b>	\$0	<u>&amp;</u>	\$0	\$0

Government Stakeholder         Non-Recurring Expenditures         Recurring Expenditures           system         Subsystem Name         1-5         6-10         11-20         5         10           Commercial Vehicle Administration Subsystem         \$338         \$1         \$16         \$358         10           Commercial Vehicle Administration Subsystem         \$203         \$1         \$1         \$14         \$14           Commercial Vehicle Administration Subsystem         \$203         \$1         \$14         \$14         \$14           Emergency Management Subsystem         \$203         \$1         \$14         \$1         \$1           Emergency Vehicle Subsystem         \$0         \$1         \$1         \$1         \$1           Parking Management Subsystem         \$0         \$1         \$1         \$1         \$1           Remote Traveler Subsystem         \$0         \$1         \$1         \$1         \$1           Remote Traveler Subsystem         \$0         \$1         \$2         \$2         \$2         \$2         \$2           Infliction Subsystem         \$0         \$1         \$2         \$2         \$2         \$2         \$2         \$2           Infliction Subsystem         \$0         \$0		Equipment Package Expenditures for High Market Penetration	penditure	s for Hig	h Market	Penetrat	ion	
System         Subsystem Name         Yrs	Gove	ernment Stakeholder	Non-Recu	ırring Exper	ditures	Recur	ring Expendi	tures
System         Subsystem Name         1-5         6-10         11-20         5         10           Commercial Vehicle Administration Subsystem         \$3338         \$1         \$14         \$14           Commercial Vehicle Check Subsystem         \$405         \$3         \$101         \$14           Emergency Management Subsystem         \$203         \$1         \$0         \$1           Environmental And Emmisions Management Subsystem         \$2         \$8         \$1         \$0           Emergency Vehicle Subsystem         \$0         \$0         \$0         \$0           Planning Subsystem         \$0         \$1,094         \$1,572         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0           Toll Collection Subsystem         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$0         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Transit Management Subsystem         \$0         \$1,367         \$0         \$0           Transit Management Subsystem         \$0 <th></th> <th></th> <th>Yrs</th> <th>Yrs</th> <th>Yrs</th> <th>Average /</th> <th>Annual Exper</th> <th>nditures</th>			Yrs	Yrs	Yrs	Average /	Annual Exper	nditures
Commercial Vehicle Administration Subsystem         \$338         \$1         \$14         \$14           Commercial Vehicle Check Subsystem         \$405         \$3         \$101         \$14           Emergency Management Subsystem         \$0         \$196         \$147           Environmental And Emmisions Management Subsystem         \$0         \$1         \$0         \$0           Emergency Vehicle Subsystem         \$0         \$0         \$0         \$0         \$0           Parking Management Subsystem         \$0         \$0         \$0         \$0         \$0           Roadside Subsystem         \$0         \$1,094         \$1,572         \$0         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0         \$0           Toll Administration Subsystem         \$0         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$0         \$0         \$0         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$65         \$0         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$1,968         \$0         \$0         \$0           Transit Management	Subsystem	Subsystem Name	1-5	6-10	11-20	2	10	20
Commercial Vehicle Check Subsystem         \$405         \$3         \$101         \$14           Emergency Management Subsystem         \$0         \$196         \$147           Environmental And Emmisions Management Subsystem         \$0         \$1         \$0         \$0           Emergency Vehicle Subsystem         \$0         \$0         \$0         \$0         \$0           Parking Management Subsystem         \$0         \$0         \$0         \$0         \$0         \$0           Roadside Subsystem         \$0         \$1,094         \$1,572         \$0 <t< td=""><td>CVAS</td><td>Commmercial Vehicle Administration Subsystem</td><td>\$338</td><td>\$1</td><td>\$16</td><td>\$358</td><td>\$358</td><td>\$358</td></t<>	CVAS	Commmercial Vehicle Administration Subsystem	\$338	\$1	\$16	\$358	\$358	\$358
Emergency Management Subsystem         \$203         \$0         \$147           Environmental And Emmisions Management Subsystem         \$0         \$1         \$0         \$0           Emergency Vehicle Subsystem         \$0         \$0         \$0         \$0         \$0           Parking Management Subsystem         \$0         \$0         \$0         \$0         \$0         \$0           Roadside Subsystem         \$0         \$1,094         \$1,572         \$0         \$0         \$0           Remote Traveler Subsystem         \$0	CVCS	Commercial Vehicle Check Subsystem	\$405	\$3	\$101	\$14	\$14	\$14
Environmental And Emmisions Management Subsystem         \$0         \$1         \$0         \$0           Emergency Vehicle Subsystem         \$2         \$8         \$17         \$0           Parking Management Subsystem         \$0         \$0         \$0         \$0           Planning Subsystem         \$0         \$1,094         \$1,572         \$0           Readside Subsystem         \$0         \$1,094         \$1,572         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0           Toll Administration Subsystem         \$0         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$67         \$91         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$6         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$1,968         \$0         \$0           Transit Management Subsystem         \$0         \$0         \$0         \$0 <td< td=""><td>EMS</td><td>Emergency Management Subsystem</td><td>\$203</td><td>\$0</td><td>\$196</td><td>\$147</td><td>\$147</td><td>\$147</td></td<>	EMS	Emergency Management Subsystem	\$203	\$0	\$196	\$147	\$147	\$147
Emergency Vehicle Subsystem         \$2         \$8         \$17         \$0           Parking Management Subsystem         \$0         \$0         \$0         \$0           Planning Subsystem         \$0         \$1,094         \$1,572         \$0           Remote Traveler Subsystem         \$0         \$1,094         \$1,572         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0           Toll Administration Subsystem         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$0         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Transit Vehicle Subsystem         \$0         \$1,37         \$0         \$0	EMMS	Environmental And Emmisions Management Subsystem	\$0	\$1	\$0	\$0	\$54	\$54
Parking Management Subsystem         \$0         \$0         \$0         \$0           Planning Subsystem         \$0         \$1,094         \$1,572         \$0           Roadside Subsystem         \$0         \$1,094         \$1,572         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0           Toll Administration Subsystem         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$0         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Transit Vehicle Subsystem         \$0         \$1,368         \$0         \$0	EVS	Emergency Vehicle Subsystem	\$2	\$8	\$17	\$0	\$2	\$3
Planning Subsystem         \$0         \$0         \$0         \$0           Roadside Subsystem         \$0         \$1,094         \$1,572         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0           Toll Administration Subsystem         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$0         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Stansit Management Subsystem         \$0         \$1,968         \$85         \$0           Stansit Vehicle Subsystem         \$0         \$1,368         \$85         \$0	PMS		\$0	\$0	\$0	\$0	\$0	\$0
Remote Traveler Subsystem         \$0         \$1,094         \$1,572         \$0           Remote Traveler Subsystem         \$0         \$0         \$0         \$0           Toll Administration Subsystem         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$0         \$0         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Stansit Management Subsystem         \$0         \$1,968         \$85         \$0           Attack Vehicle Subsystem         \$0         \$1,368         \$6         \$0         \$0	PS	Planning Subsystem	\$0	\$0	\$0	\$0	\$0	\$0
Remote Traveler Subsystem         \$0         \$30         \$0           Toll Administration Subsystem         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$0         \$0         \$0         \$0           S         Transit Management Subsystem         \$0         \$1,968         \$85         \$0           S         Transit Management Subsystem         \$0         \$1,368         \$85         \$0           S         Transit Management Subsystem         \$0         \$1,368         \$85         \$0	RS	Roadside Subsystem	\$0	\$1,094	\$1,572	\$0	\$20	\$87
Toll Administration Subsystem         \$0         \$0         \$0         \$0           Toll Collection Subsystem         \$0         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$1,968         \$85         \$0           S         Transit Management Subsystem         \$0         \$1,968         \$85         \$0           S         Transit Vehicle Subsystem         \$0         \$1,368         \$0         \$0	RTS	Remote Traveler Subsystem	\$0	\$0	\$30	\$0	\$0	\$24
Toll Collection Subsystem         \$0         \$0         \$0           Traffic Management Subsystem         \$0         \$679         \$911         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Transit Vahicle Subsystem         \$0         \$133         \$137         \$0	TAS	Toll Administration Subsystem	\$0	\$0	\$0	\$0	\$0	\$0
Traffic Management Subsystem         \$0         \$679         \$911         \$0           Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Transit Vehicle Subsystem         \$0         \$133         \$137         \$0	TCS	Toll Collection Subsystem	\$0	\$0	\$0	\$0	\$0	\$0
Transit Management Subsystem         \$0         \$1,968         \$85         \$0           Transit Vehicle Subsystem         \$0         \$133         \$137         \$0	TMS	Traffic Management Subsystem	\$0	\$679	\$911	\$0	\$416	\$688
Transit Vehicle Subsystem \$0 \$133 \$137 \$0	TRMS	Transit Management Subsystem	\$0	\$1,968	\$85	\$0	\$718	\$718
	TRVS	Transit Vehide Subsystem	\$0	\$133	\$137	\$0	\$55	\$55

Expenditures are in constant 1995 dollars in (1,000's) \$3,887 \$3,065 \$519 \$1,814 \$2,148

FIGURE 7.3-3 MOUNTAINVILLE SUMMARY GOVERNMENT ONLY EXPENDITURES FOR HIGH MARKET PENETRATION

# **APPENDIX A -List of Acronyms**

A

ABS Antilock Brake System

ADA Americans with Disabilities Act
AFD Architecture Flow Diagram
AID Architecture Interconnect Diagram
AHS Automated Highway System
AMPS Advanced Mobile Phone System
ATIS Advanced Traveler Information System

ATM Asynchronous Transfer Mode

ATMS Advanced Traffic Management System
AVCS Advanced Vehicle Control System
AVI Automated Vehicle Identification
AVL Automated Vehicle Location
AVO Automated Vehicle Operation

 $\mathbf{C}$ 

CAAA Clean Air Act Amendment

CASE Computer Aided Systems Engineering

CCTV Closed Circuit TV

CDMA Code Division Multiple Access
CDPD Cellular Digital Packet Data
CMS Changeable Message System

COTR Contracting Officer Technical Representative

CSP Communication Service Provider

CVAS Commercial Vehicle Administration Subsystem

CVCS Commercial Vehicle Check Subsystem

CVISN Commercial Vehicle Information Systems and Networks

CVS Commercial Vehicle Subsystem
CVO Commercial Vehicle Operations

D

DAB Digital Audio Broadcast

DD Data Dictionary

DDE Data Dictionary Element
DFD Data Flow Diagram

DGPS Differential Global Positioning System

DOD Department of Defense
DOT Department of Transportation
DMV Department of Motor Vehicles

DSRC Dedicated Short Range Communications

DTA Dynamic Traffic Assignment

 $\mathbf{E}$ 

ECPA Electronic Communications Privacy Act

EDI Electronic Data Interchange

EPA Environmental Protection Agency
EM Emergency Management Subsystem
EMC Emergency Management Center
EMMS Emissions Management Subsystem

ESMR Enhanced SMR

ETA Expected Time of Arrival

ETTM Electronic Toll and Traffic Management

F

FARS Fatal Accident Reporting System

FCC Federal Communications Commission for the U.S.

FHWA Federal Highway Administration

FIPS Federal Information Processing Standard

FOT Field Operational Test

FMS Fleet Management Subsystem

FPR Final Program Review

FTA Federal Transit Administration

 $\mathbf{G}$ 

GIS Geographic Information System
GPS Global Positioning System

Η

HAR Highway Advisory Radio
HAZMAT HAZardous MATerial(s)
HOV High Occupancy Vehicle
HUD Head-Up Display

I

IEEE Institute of Electrical and Electronics Engineers, Inc.

IVIS In Vehicle Information System

IP Internet Protocol

IPR Interim Program Review

ISO International Standards Organization

ISP Information Service Provider

ISTEA Intermodal Surface Transportation Efficiency Act

ITEInstitute of Transportation EngineersITIIntelligent Transportation InfrastructureITSIntelligent Transportation Systems

ITS AMERICA Intelligent Transportation Society of America

IVHS Intelligent Vehicle Highway Systems

2 June 1996

L

LAN Local Area Network
LCD Liquid Crystal Display
LED Light Emitting Diode

LEO Low–Earth Orbit satellite system LPD Liability and Property Damage

LRMP Location Reference Messaging Protocol LRMS Location Reference Messaging Standard

M

MAN Metropolitan Area Network
MAUT Multiattribute Utility Theory

MMI Man–Machine Interface (or Interaction)

MOE Measure Of Effectiveness

MPO Metropolitan Planning Organization

MPH Miles per Hour MTC Metro Traffic Control

N

NA National Architecture
NAR National Architecture Review

NEMA National Electrical Manufacturers Association

NHPN National Highway Planning Network

NHTSA National Highway Traffic Safety Administration
NII National Information Infrastructure (aka Information

Superhighway)

NTCIP National Transportation Communications for ITS Protocol

 $\mathbf{0}$ 

OEM Original Equipment Manufacturer
OSI Open Systems Interconnection

OTP Operational Test Plan

P

PCS Personal Communications System

PDA Personal Digital Assistant

PIAS Personal Information Access Subsystem
PMS Parking Management Subsystem

PS Planning Subsystem

PSA Precursor System Architecture

PSPEC Process Specification

PSTN Public Switched Telephone Network

Q

QFD Quality Functional Deployment

3 June 1996

R

R&D Research and Development

RDS Radio Data Systems

RDS-TMC Radio Data Systems incorporating a Traffic Message

Channel

RTA Regional Transit Authority
RS Roadway Subsystem

RTS Remote Traveler Support Subsystem

S

SAE Society of Automotive Engineers
SDO Standards Development Organization

SMR Specialized Mobile Radio
SONET Synchronous Optical Network
SOV Single Occupancy Vehicle

STMF Simple Transportation Management Framework

SQL Standard Query Language

T

TAS Toll Administration Subsystem
TCS Toll Collection Subsystem
TDM Travel Demand Management
TDMA Time Division Multiple Access

TIGER Topologically Integrated Geographic Encoding &

Referencing files

TMC 1. Traffic Management Center

2. Traffic Message Channel. See RDS-TMC

TMS Traffic Management Subsystem
TRMC Transit Management Center
TRMS Transit Management Subsystem
TRT Technical Review Team

TRVS Transit Vehicle Subsystem

 $\mathbf{V}$ 

VMS Variable Message Sign

VRC Vehicle/Roadside Communications

VS Vehicle Subsystem

 $\mathbf{W}$ 

WAN Wide Area Network
WIM Weigh–in Motion
WWW World Wide Web

4 June 1996

# ITS Architecture Cost Analysis Addendum for Highway Rail Interface (HRI) Final Delivery

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#### 1. INTRODUCTION

The goal of the Highway Rail Interface (HRI) addendum to the Cost Analysis for Phase 2 of the National ITS Architecture project is to produce a high-level estimate of the expenditures associated with implementing the physical elements and the functional capabilities of the HRI User Service as it is likely to be deployed under the confines of the National ITS Architecture. A second goal of the HRI cost evaluation is to provide a costing tool for ITS implementors. The range of unit prices and quantities provided throughout the evaluation may be used in determining appropriate deployment plans and strategies.

The analysis addresses expenditures for equipment deployment, as well as operations and maintenance for the subsystems identified in the physical architecture. The HRI cost evaluation is based on the updated Phase II physical architecture which includes additions to and modifications of the subsystems listed below.

- Roadway Subsystem (RS)
- Traffic Management Subsystem (TMS)

In accordance with FHWA costing guidelines, the phase two analyses include the cost evaluation of three distinct deployment scenarios. These scenarios cover an urban, inter-urban, and rural settings over 5, 10, and 20 year time frames measured from 1992 according to FHWA guidelines. For HRI the same scenarios and time frames will be used. Not all HRI related equipment packages are deployed in each scenario. However, among the three scenarios, each HRI related equipment package is deployed in at least one area. The analyses assume a twenty-year deployment period and account for both non-recurring and recurring costs (operations and maintenance activities).

The accuracy of any cost evaluation is a function of evaluating the state-of-the-practice, the state-of-the-art, or the yet to be defined technology. The delivery of HRI related services encompasses all three of these situations. Where the state-of-the-practice technology is being deployed in the delivery of ITS services, the accuracy of the cost evaluation is significantly better than cost estimates for developing technology and those technologies which are still in the research stages. This being the case, the unit prices for near term deployed and currently deployed ITS systems rely on existing price catalogs, state's department of transportation construction pay item ranges, as well as other public records including construction bid unit prices.

Where feasible, a range of estimates is provided for specific technology equipment. This range should be balanced with local construction pricing indices, such as the Means Cost Estimating Indices.

# 1.1 Organization of Report

This HRI addendum to the Cost Analysis report is separated into seven main sections.

After this introduction section 2 outlines the objectives of the National ITS Architecture Cost Evaluation for HRI.

Section 3 provides a basic definition of the terms utilized in the HRI costing exercise. The relationships of ITS User Services to the deployable physical devices which provide the required functionality of the services is provided in chapter two.

Section 4 details the methodology for determining expenditures for each ITS HRI service through the deployment of Equipment Packages. This methodology can be used for determining the expenditures for

each Equipment Package based on any specified scenario. For HRI, the quantities of equipment packages as deployed in the three scenarios are also defined in section 4 instead of creating a standalone Evaluatory Design Document for HRI.

Sections 5, 6, and 7 provide examples of expenditure calculations for the specified scenarios, Urbansville, Thruville, and Mountainville, respectively. These sections demonstrate the execution of the methodology outlined in section 4, as well as demonstrate the assumptions necessary in determining the costing parameters.

# 1.2 Relationship to Other Documents

This report is written as part of a series of reports for the National ITS Architecture Program. While much of this report may be used without outside reference, there is specific reliance of the HRI Cost Analysis on several of the other documents.

The Physical and Logical Architecture documents represent the core descriptions of the national architecture structure. Their relationship to the cost document is significant in that the bases for the cost evaluation are deployment scenarios as functions of the national architecture.

The Theory of Operations provides a description of how the architecture provides for user services. The concepts of this document have been incorporated into the Cost Evaluation document through the establishment of sample deployment scenarios.

The Implementation Strategy describes the various issues and concerns in deploying ITS services. Stakeholder relationships, required interactions, and potential partnerships are detailed as they relate to implementing various services. The Implementation Strategy develops the concept of market packages that are used to group services that are allocated to the User Services and are used in cost/benefit analysis.

For HRI the information that was previously defined in the Evaluatory Design Document is included in section 4.5 of this document. That section identifies the parameters utilized to evaluate the architecture and market penetration values for each of the affected equipment packages.

#### 1.3 Relationship to the ITS National Architecture

This Cost Analysis Addendum for HRI contains an evaluation of expenditures for sample deployments of HRI related ITS services. By its nature, a cost for the architecture itself cannot be quantified. What is quantified is the expenditure of sample implementations of the architecture, or system designs of HRI related ITS service deployments. These are sample deployments and do not encompass all deployment variations possible under the architecture framework.

# 2. OBJECTIVES

The objectives of the HRI cost evaluation of the National ITS Architecture can be summarized as follows:

- 1. To produce a highlevel cost estimate of the implementation of the functional capabilities supported by the architecture.
- 2. To allocate expenditures into recurring, and nonecurring (including life cycle expenditures) categories.
- 3. To support analysis of design tradeoffs and provide expenditure data for analyzing the implementation alternatives.
- 4. To develop quantity, prices and expenditure estimates of the ITS architecture implementation to aid in FHWA's overall evaluation of alternative implementation strategies.
- 5. To develop estimates of the level and time line of the estimated government investment necessary for the ITS architecture deployment.
- 6. To provide elemental costs for implementors, which allow the Equipment Package Unit Price Worksheets to be utilized in costing ITS implementations for any designated deployment.

# 3. EQUIPMENT PACKAGE DEFINITION

The expenditures and unit prices utilized in this ITS National Architecture Evaluation for HRI represent the final price of the installed equipment instead of the manufacturer's cost of production. A manufacturer's cost of production is only one factor in determining the final price for a product which the market will bear and for which a reasonable profit may be made. Research and development costs, production costs, transportation costs, intermediary shippers' and handlers' costs, marketing costs, and retail markups are all a part of the determination of the final retail price of a product. These items are very difficult to estimate in developing manufacturing industries. Therefore, the expenditures presented in this analysis represent estimates of retail prices for equipment and staff based on comparable technology retail pricing, or estimates of market prices based on historical pricing strategies for specific industries.

Formulating unit prices for the devices involves cost recovery concepts and the following considerations:

- The total cumulative volume of that product which will be sold to all possible customers, over a period of years.
- The cost of software per product that is generally spread across all customer volumes, but includes considerations that a portion of that software was used previously, and / or if it can be shared by another product under development.
- Considerable tooling expense, and test equipment capital expense in the manufacturing of electronics.
- The cost of product recall if it is related to the safety or emissions;
- Target pricing policies, wherein the component product supplier is given a specified selling price. This policy invariably leads to a negotiating process involving component product specifications, and quality control issues.

To develop Unit Prices this analysis compares the Equipment Packages to similarly available commercial products. In addition, these comparisons are tempered by the likely total volumes of the product by a given supplier.

The basis for cost analysis is the set of HRI related Equipment Packages and the two affected subsystems of the Physical Architecture.

Subsystems perform transportation functions (e.g., collect data from the roadside, perform route planning, etc.) All of the functions are defined in the logical architecture as process specifications. Processes that are likely to be collected together under one physical agency, jurisdiction, or physical unit are grouped together into a subsystem. This grouping is done to optimize the overall expected performance of the resulting ITS deployments taking into consideration anticipated communication technologies, performance, risk, deployment, etc.

The Equipment Packages represent subsets of functionality within a single Subsystem. The HRI Equipment Packages are described in sections 4.6.

#### 4. METHODOLOGY

This section outlines the steps necessary to determine a specific ITS deployment scenario's expenditures that are independent from the prescribed Urbansville, Thruville, and Mountainville scenarios provided by FHWA.

For reference, sample calculations for deployed services are provided in Sections 5, 6, and 7 for the prescribed typical areas, the urban area, interurban area, and rural area. The cost evaluation in these later chapters evaluates five, ten and twenty year deployment milestones based on the evaluatory design parameters and market penetrations which, for HRI, are specified in section 4.5. The analyses also assumes operations and maintenance schedules for this period, during which all devices remain operable and expenditures required to facilitate the Market Packages are incurred through life cycle costing.

# 4.1 Summary of Approach

The cost evaluation is conducted based on 1995 constant dollars for the unit prices in determining Equipment Package expenditure. The evaluation approach discussed below may be used by other groups implementing ITS services in determining conceptual pricing and expenditures for various services. The essential steps in cost evaluations are outlined below:

- 1. Definition of the ITS baseline for HRI that represents a reference point for the development and cost analysis of a future deployment.
- 2. Identification of the HRI related Market Packages that provide various levels of service to the users at various costs. The selection of Equipment Packages for the HRI User Service will span across Subsystems, as Market Packages require the functionality from multiple architectural Subsystems.
- 3. Examination of the lists of equipment as itemized in the Equipment Package Worksheets.
- 4. Examination of unit prices for end user services and/or packages of such equipment.
- 5. Identification and evaluation of equipment, quantities, and timing for a local deployment.
- 6. Calculation of the parametric quantities.
- 7. Calculation of the expenditure matrices for Equipment Packages.
- 8. Summation of Equipment Package expenditures to determine Market Packages expenditures.

The outputs of this analysis are the following:

- Equipment Package identification and existing technology components listing
- Matrices of Quantities for each scenario
- Matrices of unit prices for each Equipment Package
- Matrices of expenditures for each Equipment Package, for the specific scenario, for the analysis period.

# 4.2 End User Expenditures

End user expenditures, for any deployment, are the results of multiplying the quantities of items purchased for that deployment with the unit prices for each quantity item to be deployed in the scenario. The Equipment Packages are the basis for pricing strategies of an ITS deployment and are segregated by the architectural Subsystems. Each Equipment Package will have a time period of deployment, defined by the planned evolutionary deployment.

Of the various stakeholder groups represented across all of ITS, the Public/Government Sector is the only stakeholder group affected by the HRI unique equipment packages.

For every Equipment Package, there are two financial flows: (1) non-recurring expenditures, the initial funding or financing of service delivery and (2) recurring expenditures, the expenditures for continual operation and maintenance of the Equipment Packages.

Recurring expenditure items include consumables for the equipment as well as for service fees and access expenditures. Replacement devices with useful lives of one year or less are included in the recurring expenditure tabulations.

# 4.3 Life Cycle Costing

Life cycle expenditures for the nomecurring HRI related items are accounted for by full replacement at the end of the scheduled useful life. Refer to the original Cost Analysis document for more information.

The life cycle expenditures for alternative technology used in Equipment Packages may be evaluated and compared using the baseline deployment technology listed in the Worksheets.

# 4.4 Analytical Tools

Included with this document are spreadsheets for calculating end user expenditures for specific deployments, and other variations on the three FHWA provided scenarios.

The HRI cost analysis uses the same scenarios and time frames analyzed in the original Cost Analysis. An evaluatory design for the HRI specific components is included in section 4.5.

In these spreadsheets the annual expenditures are tabulated in the matrix for a total of twenty years. As certain Market Packages are deployed and become operational, the recurring operation and maintenance expenditures become activated, and the life cycle for the system components begins.

The Equipment Package Unit Price Worksheets contain the itemized listings of equipment as well as additional staffing requirements, equipment maintenance requirements, and operations required communications.

These assumptions and deployment designs for the three typical design scenarios provide some insight into selecting parameters for each Equipment Package.

#### 4.5 Analytical Procedure

The HRI cost evaluation procedure develops an expenditure profile for the HRI User Service and the associated Market Packages. The expenditure profile includes a time frame for analysis in order to

evaluate life cycle costs, as well as to obtain a feeling for the relative dimensions of non-recurring costs (initial capital expenditures) and recurring costs (annual operation and maintenance expenditures.)

#### **4.5.1 Definition of ITS Baseline**

For the purposes of the Cost Analysis, the ITS baseline is a definition of what ITS equipment is in place prior to the start of the analysis period. The baseline for analysis, in general, assumes that there is no current ITS technology deployed. For each implementor's scenario, an inventory of existing systems is necessary. This inventory includes such items as signal controller technology, existing closed loop signal controls, existing traffic control/management facility capabilities and limitations, existing transit facility technology, existing emergency facilities, existing communication network along the roadway infrastructure, etc.

For HRI, many intersections have already been equipped with active gates and signals. This cost analysis will assume that a percentage of the HRIs in the regions under study will have been equipped with the active gates and will not include that cost in the total cost to deploy the ITS Equipment Packages. There is also assumed to be an existing set of traffic management roadside equipment including adjacent closed-loop signal control and communications to the Traffic Management Center (TMC).

# 4.5.2 Market Package Selection

For the HRI User Service 3 new Market Packages have been created:

- Standard Railroad Grade Crossing
- Advanced Railroad Grade Crossing
- Railroad Operations Coordination

In addition, 4 existing market packages satisfy elements of the HRI User Service:

- In Vehicle Signing
- Surface Street Control
- Traffic Information Dissemination
- Intersection Collision Avoidance

The deployment timing for Equipment Packages is detailed in the market penetrations of the equipment packages being deployed as part of these market packages.

Table 4-1 shows the relationship of market packages, equipment packages, and subsystems for the new and some of the existing market packages which satisfy the HRI requirements.

Table 4-1. Market Package to Equipment Package Relationship

Market Package	Market Package Name	Subsystem	<b>Equipment Package Name</b>
ATIS9	In Vehicle Signing	TMS	TMC Input to In-Vehicle Signing
		RS	Roadway In-Vehicle Signing
		VS	In-Vehicle Signing System
ATMS03	Surface Street Control	TMS	Traffic Maintenance
		TMS	TMC Basic Signal Control
		RS	Roadway Signal Controls
ATMS06	Traffic Information Dissemination	RS	Roadway Traffic Information Dissemination

Market Package	Market Package Name	Subsystem	Equipment Package Name
		TMS	TMC Traffic Information Dissemination
ATMS13	Standard Railroad Grade Crossing	RS	Standard Rail Crossing
		TMS	HRI Traffic Management
ATMS14	Advanced Railroad Grade Crossing	RS	Advanced Rail Crossing
		TMS	HRI Traffic Management
ATMS15	Railroad Operations Coordination	TMS	Rail Operations Coordination
AVSS10	Intersection Collision Avoidance	RS	Roadway Intersection Collision System
		VS	Vehicle Intersection Control

The equipment packages that make up Surface Street Control will not be listed in this cost analysis for HRI because the equipment is already considered in the current ITS cost model. The equipment packages that make up Intersection Collision Avoidance will not be listed either because the quantities deployed will be essentially zero in the time frames covered by this analysis.

# 4.5.3 Identification of Architectural Subsystems

This step identifies the required subsystems for the implementation of the HRI Market Packages. As shown in Table 4-1 there are 3 subsystems affected by the addition of HRI:

- Roadway Subsystem
- Traffic Management Subsystem
- Vehicle Subsystem

For this cost analysis none of the equipment packages located in the vehicle subsystem will be priced under the expectation that no additional cost will be placed on the consumer specifically for HRI. The Equipment Packages included in this cost analysis are as follows:

- HRI Traffic Management -This equipment package monitors highway-rail intersection (HRI) equipment at the roadside which manages highway traffic.
- Rail Operations Coordination This resides in the TMS to coordinate with the rail operators as well as the other TMS functions.
- Standard Rail Crossing This equipment package detects oncoming trains and controls the crossing gates/signals as well as pass the information to any adjacent signals to preempt the normal light timing.
- Advanced Rail Crossing Additional functionality is incorporated here to detect entrapped vehicles in the 4 quadrant gate system and notify the engineers through the wayside equipment.
- Roadway In-Vehicle Signing The analysis of this existing equipment package includes the additional signing beacons to be placed around the HRIs.
- Roadway Traffic Information Dissemination The analysis of this existing equipment package
  includes a number of additional changeable message signs that will be added around many of
  the HRIs.

# 4.5.4 Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the section 4.6. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and

maintenance requirements. A review of the equipment listed and a comparison to the preferred local technology may yield different expenditure estimates. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology and developing technology, also using comparable technology.

#### 4.5.5 Identification and Evaluation of Quantities and Market Size

The quantity of items purchased influences the unit price for the equipment. Price breaks come into effect when larger quantities are purchased. One consideration to take into account, when developing the parametric quantities is the existing product development curve. For existing technology, many equipment prices are at a steady state price. The prices are generally not subject to wide fluctuations based on quantities. Newer technology or services which are on the front end of a market/product development curve are subject to wide price ranges. Early deployments are obviously higher priced. The implementor may make a judgement as to the particular product development based on the existence of other similar systems in operation.

For HRI an evaluatory design is captured by defining specific implementations for each of the HRI related equipment packages present in the 3 scenarios (urban, interurban, and rural). The urban scenario, Urbansville, is based upon the area surrounding and including Detroit, MI. The counties included are Macomb, Oakland, and Wayne counties. The interurban scenario, Thruville, depicts the region along the New Jersey turnpike. The counties included are Burlington, Camden, and Gloucester counties in New Jersey. The rural scenario, Mountainville, is based on Lincoln county, Montana.

The total population for which each of the equipment packages being studied is applicable is defined as a list of parameters. These parameters are quantified based on available statistical information, data provided by the government in the scenario definitions, or assumptions about the deployment of ITS.

For HRI, one existing parameter will be retained as is from the Evaluatory Design and Cost Analysis published at the time of the National Architecture Review (NAR):

• Traffic\_Management\_Centers: The number of TMCs grows over time in Urbansville and Thruville as more municipalities implement ITS. Mountainville is not expected to have a TMC.

For HRI, 2 new parameters have been added:

• Passive\_HRIs\_Upgraded: A database report from the Federal Railroad Administration developed in December 1996 lists the number of passive (no gates or signals) as well as active (gates or signals) in each of the counties that make up the Evaluation Scenarios for the ITS architecture development. This parameter is considered the total number of crossings in the region under study that will likely be upgraded to an active set of equipment over the next 20 years. It was derived from the total number of passive crossings and multiplied by one-half to account for crossings that will be closed or left as passive. This figure was loosely based on planning information from the Toledo Metropolitan Area Council of Governments (TMACOG) concerning the status of their inventory of some 517 crossings. Of that total 142 were public crossings with crossbucks. TMACOG has a published plan to upgrade the crossings to Gates and lights over the next 20 years if they are in either a corridor where train speeds are greater than 80 mph or either high train traffic or high motor vehicle traffic. The result is that 74 of the 142 passive crossings are planned to be upgraded. These passive crossings are candidates for deployment of the Standard Rail Crossing equipment package.

Active\_HRIs: The number of at-grade highway rail intersections that are currently equipped
with active gates and/or signals is from the same FRA database report for the counties in the
evaluation scenarios. These active crossings will either be equipped with the Standard Rail
Crossing package or the Advanced Rail Crossing package.

The quantities of two existing parameters will be increased to support HRI:

- Changeable Message Signs: Adjacent to some of the HRIs, these signs will receive input from the TMS to display an advisory message about an oncoming or passing train. This is not as large, nor does it display as complex a message set as the CMS located along freeways but it will accept input and be able to display any of 2 or 3 very brief messages. For this evaluation, theses signs will be located at 40% of the passive and active Highway Rail Intersections that are being installed with the ITS packages.
- In-Vehicle Signing Beacons: At some HRIs, a beacon type device will be used to receive input from the TMS and broadcast an advisory to nearby vehicles equipped with in-vehicle signage. For this evaluation, theses beacons will be located at 25% of the passive and active Highway Rail Intersections that are being installed with the ITS packages.

The evaluatory design parameters for HRI are shown ihable 4-2 below.

Table 4-2. Evaluation Parameters for HRI

	Table 4-2. Eval	uauon	l I al a	meters	5 101 1.	III				
		U	rbansvi	lle		Thruville	•	Мо	untainv	ille
Source Parameters	Basis	5 yr	10 yr	20 yr	5 yr	10 yr	20 yr	5 yr	10 yr	20 yr
Centers										
Traffic_Management_Centers	NAR Ev Design	2	3	5	1	1	2	0	0	0
Roadway Characteristics										
Passive_HRIs_Upgraded	FRA Data; 1/2 of Current Passive HRIs	109	109	109	61	61	61	10	10	10
Active_HRIs	FRA Data	559	559	559	230	230	230	5	5	5
CMS for HRI	40% of Passive/Active HRIs	267	267	267	116	116	116	6	6	6
In-Vehicle Signing Beacons for HRI	25% of Passive/Active HRIs	167	167	167	73	73	73	4	4	4

For each equipment package being studied a market penetration is developed by scenario and time frame. Expected market penetrations are based upon studies from the University of Michigan Transportation Research Institute (UMTRI), research done during phase I of the architecture program by the Rockwell team, and expert opinions of team members for users services not covered by the other services. Also useful in building the penetration matrices was the Market Package Deployment Timing in the Implementation Strategy document.

Four new equipment packages have been identified to be added for HRI:

- HRI Traffic Management: Penetration is expected to grow from 0 at 5 years to 100% of all TMCs equipped at 20 years for Urban and Interurban. This package will not be deployed in a rural environment.
- Rail Operations Coordination: Penetration is expected to grow from 0 at 5 years to 100% of all TMCs equipped at 20 years for Urban and Interurban. This package will not be deployed in a rural environment.

- Standard Rail Crossing: Penetration is expected to grow from 0 at 5 years to 50% of all intersections that have active equipment over the next 20 years. This includes the HRIs that are now passive crossings but will be upgraded to active in this overall timeframe.
- Advanced Rail Crossing: Penetration is expected to grow from 0 at 5 years to 10% of all Active rail intersections equipped at 20 years. This based on the estimated number of crossings along what are expected to be come high speed rail routes in the next 20 years. In the TMACOG planning data this includes as many as 48 of their 188 active public crossings, or 25%. This analysis will use a figure of 10% with the understanding that other crossings may be grade separated or closed entirely to accommodate the higher speed services.

Components of 2 existing equipment packages will be increased to account for the rail crossings.

- Roadway In-Vehicle Signing: Installment, or penetration, is expected to grow from 0 at 5 years to 100% of all possible HRI beacon locations at 20 years.
- Roadway Traffic Information Dissemination: Installment, or penetration, is expected to grow from 0 at 5 years to 100% of all possible HRI CMS locations at 20 years.

Table 4-3 lists the estimated penetrations for each of the HRI related equipment packages for each geographic scenario and time frame.

Table 4-3. Market Penetrations for HRI

Subsystem	EP ID	Equipment Package	Source Parameters	5 yr Low	5 yr High	10 yr Low	10 yr High	20 yr Low	20 yr High
		Urba	nsville - Urban Sc	enario					
TMS	TMS18	HRI Traffic Management	TMCs	0%	0%	33%	66%	60%	100%
TMS	TMS19	Rail Operations Coordination	TMCs	0%	0%	33%	66%	60%	100%
RS	RS15a	Standard Rail Crossing	Active_HRIs	0%	0%	15%	33%	30%	50%
RS	RS15b	Standard Rail Crossing	Passive_HRIs_Up graded	0%	0%	15%	33%	30%	50%
RS	RS16	Advanced Rail Crossing	Active_HRIs	0%	0%	3%	7%	6%	10%
RS	RS7a	Roadway In-Vehicle Signing Additional for HRI	In-Vehicle Signing Beacons for HRI	0%	0%	33%	66%	60%	100%
RS	RS14a	Roadway Traffic Information Dissemination Additional for HR	CMS for HRI	0%	0%	33%	66%	60%	100%
		Thruv	ille - Interurban S	cenario	)				
TMS	TMS18	HRI Traffic Management	TMCs	0%	0%	30%	60%	60%	100%
TMS	TMS19	Rail Operations Coordination	TMCs	0%	0%	30%	60%	60%	100%
RS	RS15a	Standard Rail Crossing	Active_HRIs	0%	0%	15%	30%	30%	50%
RS	RS15b	Standard Rail Crossing	Passive_HRIs_Up graded	0%	0%	15%	30%	30%	50%
RS	RS16	Advanced Rail Crossing	Active_HRIs	0%	0%	3%	6%	6%	10%
RS	RS7a	Roadway In-Vehicle Signing Additional for HRI	In-Vehicle Signing Beacons for HRI	0%	0%	30%	60%	60%	100%
RS	RS14a	Roadway Traffic Information Dissemination Additional for HR	CMS for HRI	0%	0%	30%	60%	60%	100%

Subsystem	EP ID	Equipment Package	Source Parameters	5 yr Low	5 yr High	10 yr Low	10 yr High	20 yr Low	20 yr High
		Mour	tainville - Rural S	cenario	)				
TMS	TMS18	HRI Traffic Management	TMCs	0%	0%	0%	0%	0%	0%
TMS	TMS19	Rail Operations Coordination	TMCs	0%	0%	0%	0%	0%	0%
RS	RS15a	Standard Rail Crossing	Active_HRIs	0%	0%	15%	30%	30%	50%

Subsystem	EP ID	Equipment Package	Source Parameters	5 yr Low	5 yr High	10 yr Low	10 yr High	20 yr Low	20 yr High
RS	RS15b	Standard Rail Crossing	Passive_HRIs_Up graded	0%	0%	15%	30%	30%	50%
RS	RS16	Advanced Rail Crossing	Active_HRIs	0%	0%	3%	6%	6%	10%
RS	RS7a	Roadway In-Vehicle Signing Additional for HRI	In-Vehicle Signing Beacons for HRI	0%	0%	30%	60%	60%	100%
RS		Roadway Traffic Information Dissemination Additional for HR	CMS for HRI	0%	0%	30%	60%	60%	100%

The quantities of equipment packages that are used in the cost analysis is computed by multiplying each of the market penetrations against its source parameterTable 4-4 lists the calculated quantities (parameter x penetration) for each of the HRI related equipment packages for each geographic scenario and time frame.

Table 4-4. HRI Evaluatory Design Quantities

Subsystem	EP ID	Equipment Package	5 yr Low	5 yr High	10 yr Low	10 yr High	20 yr Low	20 yr High
	•	Urbansville	- Urban So	enario	'	'.		
TMS	TMS18	HRI Traffic Management	0	0	1	2	3	5
TMS	TMS19	Rail Operations Coordination	0	0	1	2	3	5
RS	RS15a	Standard Rail Crossing	0	0	84	184	168	280
RS	RS15b	Standard Rail Crossing	0	0	16	36	33	55
RS	RS16	Advanced Rail Crossing	0	0	17	39	34	56
RS	RS7a	Roadway In-Vehicle Signing Additions for HRI	al O	0	55	110	100	167
RS	RS14a	Roadway Traffic Information Dissemination Additional for HRI	0	0	88	176	160	267
		Thruville - In	terurban S	cenario				
TMS	TMS18	HRI Traffic Management	0	0	0	1	1	2
TMS	TMS19	Rail Operations Coordination	0	0	0	1	1	2
RS	RS15a	Standard Rail Crossing	0	0	35	69	69	115
RS	RS15b	Standard Rail Crossing	0	0	9	18	18	30
RS	RS16	Advanced Rail Crossing	0	0	7	14	14	23
RS	RS7a	Roadway In-Vehicle Signing Additions for HRI	al O	0	22	44	44	73
RS	RS14a	Roadway Traffic Information Dissemination Additional for HRI	0	0	35	70	70	116
		Mountainvill	e - Rural S	cenario				
TMS	TMS18	HRI Traffic Management	0	0	0	0	0	0
TMS	TMS19	Rail Operations Coordination	0	0	0	0	0	0
RS	RS15a	Standard Rail Crossing	0	0	1	2	2	3
RS	RS15b	Standard Rail Crossing	0	0	2	3	3	5
RS	RS16	Advanced Rail Crossing	0	0	0	0	0	1
RS	RS7a	Roadway In-Vehicle Signing Additions for HRI	al O	0	1	2	2	4
RS	RS14a	Roadway Traffic Information Dissemination Additional for HRI	0	0	2	4	4	6

# 4.5.6 Calculation of Expenditure Matrices for Equipment Packages

Expenditure Matrices are calculated automatically through the linked spreadsheet programs. Included in the calculation are non-recurring expenditures (one-time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred during the year of deployment for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets.

#### **4.5.7 Summary of Equipment Package Expenditures**

This step tabulates the Equipment Package expenditures for the government stakeholder which are attributable to government investment which is all of the expenditures for HRI.

# **4.6 Equipment Package Worksheets**

The Equipment Package Worksheets presented below are only those Equipment Packages which are involved in providing HRI services as defined in the previous sections. These Equipment Packages are contained in two subsystems, Roadway and Traffic Management. These Equipment Package Unit Price Worksheets describe the various pieces of equipment, computer software, and hardware, as well as operation and maintenance components that are required to provide the functional services as described in the Equipment Package definitions. As noted in the previous Cost Analysis Document, there is some common equipment through the various subsystems. This equipment centered around the communications equipment and usage for wireline and wireless service.

For this HRI Cost Analysis, the common equipment description for wireline service is repeated below.

Wireline Communication levels stem from the communication layer of the architecture and the resulting usage rates for data, voice, and image transfer from Equipment Packages across Subsystems and from Equipment Package to Equipment Package within each Subsystem. The wireline unit prices are based upon current pricing structure for telephone company provided circuits. These are based on leased digital circuits, which appear to be the most feasible option notwithstanding the preferences of the local implementors.

A full life cycle cost analysis for the tradeoff of leased verses owned lines for implementors is a local study which must take into account many factors that are external to a strictly accounting function of life cycle costing. The information provided in this cost analysis may be used by local implementors as a comparison for these local studies.

The types of the leased lines for these circuits are grouped into three categories. These include the DS0 circuits which have a capacity of 56 Kbps, the DS1 circuits (comparable to a T1 rate) have a capacity of 1.544 Mbps, and the DS3 circuits which have a capacity of 44.736 Mbps. Individual circuits may be multiplexed to provide a desired data rate that falls somewhere in the middle of these ranges.

The prices for these line types are based upon national averages for GTE services. National studies have found that some charges may vary as much as 100% between telephone companies and regions. The unit prices utilized represent both high and low ranges for typical leased lines. The typical distance for these prices is eight to fifteen miles, but most of the cost is not distance sensitive. The part of the communication link from the telephone central office to the equipment using the line is not a major component of the total line cost. The length of line between central telephone offices is the chief component of the unit prices. Many telephone companies have upgraded their central offices to digital transmission facilities thus providing the cost of analog leased lines, with a maximum guaranteed data rate of 9600 baud, to be approximately the same cost as the DS0 digital lines. The unit prices for these lines are described below. The prices given may be discounted further (up to 50%) for multiple line users and long term (five year)

commitments or contracts. This discounting is advantageous, but not relied upon for this cost analysis as the decisions for these discounts usually falls under the institutional layer of the architecture.

		Mont	hly Price
Line Type	<b>Available Capacity</b>	Low	High
DS0	56 Kbps	\$50	\$100
DS1	1.544 Mbps	\$400	\$700
DS3	44.736 Mbps	\$2000	\$6000

For this HRI Cost Analysis, there is only one line type required, DS0. Wireless communications are provided for In-Vehicle Signing through the beacons located at the highway - rail intersections. This type of communication service does not have a direct communication cost to the user.

#### 4.6.1 Traffic Management Subsystem, (TMS)

As stated earlier, this subsystem has two Equipment Packages which are factors in providing HRI services. These Equipment Packages are the following:

<b>Equipment Package Name</b>	Descriptor
HRI Traffic Management	TMS18
Rail Operations Coordination	TMS19

These descriptors represent a continuation of descriptors utilized in the previous cost analysis. Each Equipment Package function and pertinent equipment is described below.

#### **4.6.1.1** HRI Traffic Management (TMS18)

This Equipment Package monitors highway-rail intersection (HRI) equipment at the roadside which manages highway traffic. Various levels of roadside equipment may be interfaced to, and supported by, this equipment package to include standard speed active warning systems and high speed systems which provide additional information on approaching trains and detect and report on obstructions in the HRI. This Equipment Package remotely monitors and reports the status of this roadside equipment. A two way interface supports explicitly status requests or remote control plan updates to be generated by this Equipment Package. Status may also be received periodically in the absence of a request or asynchronously in the event of a detected failure or other unsafe condition at the intersection.

This Equipment Package builds on the existence of the Traffic Management Center. There is no construction of a dedicated facility. The expense for the facility is in recurring expenditures of rental costs. The initial basic communication lines are in-place, and only those changes necessary to incorporate the additional capabilities are included in the analysis.

Average annual staff unit prices vary according to the functions performed. Generally, it is anticipated that a base salary is multiplied by a benefits factor for overhead, overtime, other benefits, including \$4,500 for building rent. This number is based on an assumed annual rent charge of \$18 per square foot with an estimated average of 250 square foot per staff member.

This Equipment Package builds on the existence of TMC Basic Signal Control (TMS6). Equipment addons for include software for increased signal control and part time staffing support. It is assumed that this function will be performed by staff assigned to multiple duties. Therefore, the labor cost of the staff is assumed to be split between functionality and Equipment Packages. Thus, only fifty percent of the staff time and labor expense is attributable to this Equipment Package.

Communication lines for transmitting to roadside signal controllers is included in TMS6.

# **4.6.1.2** Rail Operations Coordination (TMS19)

This Equipment Package provides strategic coordination between rail operations and traffic management centers. It receives train schedules, maintenance schedules, and any other forecast events which will result in highway-rail intersection (HRI) closures from Rail Operations. The provided information is used to develop forecast HRI closure times and durations which may be applied in advanced traffic control strategies or delivered as enhanced traveler information. This Equipment Package includes the processing and algorithms necessary to derive HRI closure times and the communications capabilities necessary to communicate with rail operations and interface to the traffic control and information distribution capabilities included in other Traffic Management Subsystem Equipment Packages.

This Equipment Package also builds on the existence of the Traffic Management Center. There is no construction of a dedicated facility. The expense for the facility is in recurring expenditures of rental costs. The initial basic communication lines are in-place, and only those changes necessary to incorporate the additional capabilities are included in the analysis.

Average annual staff unit prices vary according to the functions performed. Generally, it is anticipated that a base salary is multiplied by a benefits factor for overhead, overtime, other benefits, including \$4,500 for building rent. This number is based on an assumed annual rent charge of \$18 per square foot with an estimated average of 250 square foot per staff member.

This Equipment Package builds on the existence of TMC Advanced Signal Control (TMS3), and TMC Basic Signal Control (TMS6). Equipment add-ons include software used to coordinate with rail operators, derive HRI closure times, provide the communications capabilities necessary to communicate with rail operations, and interface to the traffic control and information distribution capabilities. Additional staff is required in the TMC to perform this work. It is assumed that this function will be performed by staff assigned to multiple duties. Therefore, the labor cost of the staff is assumed to be split between functionality and Equipment Packages. Thus, only fifty percent of the staff time and labor expense is attributable to this Equipment Package.

An additional communication line is required for coordination activities with rail operators. Refer to the previous discussion on wireline communication costs.

Table 4-5. Unit Price Worksheet HRI Traffic Management (TMS18)

Comparative Retail Price * Unit Price Quantity	Steady State *	Estimate Per Lockheed Martin 90	and Rockwell Experience in 18	Similar Integration Projects							Steady State *	45		1.8									
Quantity Quantity (Low) (High)	Introductory State *		an	Sil							Introductory State *												
Unit Unit Price Price (Low) (High)	Introduc	90 110	18 22								Introduc	45 55		1.8 2.2									
Years to Replacement (Life Cycle)		20	2																				
Equipment Description		Integration	Software Installation and 1 year Maintenance	l e l l	ii 9 not reflect product development.			ižin	1)			Operators (1 at 50% of the time, at \$100,000)	(əɔ)	Software Maintenance Contract @ 5% of Capital Cost	eju.	is/ Note	u & Overtime, Overnead, Benefits, etc.)		1674	∌d(	0)		

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Table 4-6. Unit Price Worksheet Rail Operations Coordination (TMS19)

Quantity	ate *														ate *												dollars.
Unit Price C	Steady State	06	18					0.5							Steady State *	45		1.8				9.0					ands of 1995
Retail Price *		Estimate Per Lockheed Martin	xperience in	tion Projects				ology Prices														Structure					* All prices are in thousands of 1995 dollars.
Comparative Technology		Estimate Per L	and Rockwell Experience in	Similar Integration Projects				Existing Technology Prices														Current Price Structure	from GTE				* All p
Quantity (High)	*														*												
Quantity (Low)	Introductory State *														ory State												
Unit Price (High)	troducte	110	22					-							troducte	22		2.2				1.2					
Unit Price (Low)	<b>I</b> II	06	18			20 0.5 1 Introductory State * 45 55   1																					
Years to Replacement (Life Cycle)		20	2					20																			
Equipment Description		Integration	Software Installation and 1 year Maintenance		Note: Software is off-the-shelf technology and unit price does	not reflect product development.		Communication Line DS0 from TMC to other Rail Operators								Operators (1 at 50% of the time, at \$100,000)		Software Maintenance Contract @ 5% of Capital Cost		Note: Salary Costs are fully loaded prices (Base Salary,	Overtime, Overhead, Benefits, etc.)	Agency Wireline Communication DS0					
		•	_	uəu	uļs			stiq	Non I Ca	itia	uį	)						บรบ		uis	ırriı M	uo	ite.	iəd	0)	•	

#### 4.6.2 Roadway Subsystem, (RS)

This subsystem has two new Equipment Packages and two modified Equipment Packages which are factors in providing HRI services. These Equipment Packages are the following:

<b>Equipment Package Name</b>	Descriptor
Standard Rail Crossing	RS15
Advanced Rail Crossing	RS16
Roadway In-Vehicle Signing - Additional for HRI	RS7 (a)
Roadway Traffic Information Dissemination - Additional for HRI	RS14 (a)

These descriptors represent a continuation of descriptors utilized in the previous cost analysis. Each Equipment Package function and pertinent equipment is described below.

# 4.6.2.1 Standard Rail Crossing (RS15)

This Equipment Package manages highway traffic at highway-rail intersections (HRIs) where rail operational speeds are typically less than 80 miles per hour. Either passive (e.g., the crossbuck sign) or active warning systems (e.g., flashing lights and gates) are supported depending on the specific requirements for each intersection. These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification by interfaced wayside equipment of an approaching train. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported through interfaces to the wayside equipment and the traffic management subsystem.

Active warning systems are used for this cost analysis. For the Standard Rail Crossing, a two quadrant gate system is provided. Depending on the region in which the equipment package is deployed, many crossings will already be equipped with active gates and/or signals. The cost for new two quadrant gates for these HRIs are included as part of the unit price worksheet, but this expense is only included for the crossings that are currently passive crossings and will need to be upgraded to 2-quadrant gate systems. This is shown in the Results sections for each region. Equipment Package RS15a is for the crossings that are already active crossings. Equipment Package RS15b is for the crossings that are currently passive crossings. See Sections 5.4, 6.4, and 7.4.

The Intelligent Interface Controller (IIC) used for this HRI is assumed to be similar to a 170 type controller. Other equipment includes the Pedestrian Warning Signal and/or Gates, communication lines from the IIC to the wayside equipment, and train detection circuitry.

Staffing requirements were not considered explicitly for this Equipment Package. Rather, a broader approach (percentage of capital costs) was used in estimating the operation and maintenance costs. These percentages were estimated based on rail operation statistical averages.

#### 4.6.2.2 Advanced Rail Crossing (RS16)

This Equipment Package manages highway traffic at highway-rail intersections (HRIs) where rail operational speeds are typically greater than 80 miles per hour or where more sophisticated signaling and communications are deemed necessary. It includes all capabilities from the Standard Rail Crossing Equipment Package and augments these with additional safety features to mitigate the risks associated with higher rail speeds and higher risk crossings. The active warning systems supported by this package include

positive barrier systems which preclude entrance into the intersection when the barriers are activated. Like the Standard Rail Crossing Equipment Package, the HRI equipment is activated on notification by wayside equipment which detects, or communicates with the approaching train. In this Equipment Package, additional information about the arriving train is also provided by the wayside equipment so that the train's direction of travel, its estimated time of arrival, and the estimated duration of closure may be derived. This enhanced information may be conveyed to the driver prior to, or in context with, warning system activation. This Equipment Package also includes detection capabilities which enable it to detect an entrapped or otherwise immobilized vehicle within the HRI and provide an immediate notification to the wayside equipment and traffic management.

For the Advanced Rail Crossing, a four quadrant gate system is provided, along with a sensor system for detecting entrapped vehicles. For this cost analysis a vision based wide area detector was used. These devises currently exist and comparative technology unit prices are referenced in the worksheet.

The Intelligent Interface Controller (IIC) used for this HRI is assumed to be similar to a 170 type controller. Other equipment includes the Pedestrian Warning Signal and/or Gates, communication lines from the IIC to the wayside equipment, and train detection circuitry.

Staffing requirements were not considered explicitly for this Equipment Package. Rather, a broader approach (percentage of capital costs) was used in estimating the operation and maintenance costs. These percentages were estimated based on rail operation statistical averages.

#### 4.6.2.3 Roadway In-Vehicle Signing - Additional for HRI [RS7 (a)]

This Equipment Package provides the capability to detect local traffic flow conditions, corroborate them with a traffic management subsystem, and distribute them to the user over a short-range interface such as a radio beacon.

For this HRI Cost Analysis, the equipment depicted in the unit price worksheet is similar to that used for the same Equipment Package in the previous Cost Analysis. The difference is a slight adjustment in unit price based on a reduction of the number of beacons at the HRI intersection from four to two.

#### 4.6.2.4 Roadway Traffic Information Dissemination - Additional for HRI [RS14 (a)]

This Equipment Package provides the roadside elements of traffic information dissemination through smaller, less complex CMS. These Changeable Message Signs are not as large, nor do they contain the complex message sets of the previous units. These signs are estimated to utilize three lines of twelve inch high letters. Local memory would house the message sets, two or three variations. These signs are existing technology and the unit prices used are representative of prices from a fiber optic sign manufacturer.

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Table 4-7. Unit Price Worksheet Standard Rail Crossing (RS15)	Years to Replacement (Life Cycle)         Unit Price (Low)         Unit (Low)         Quantity (Low)         Comparative (High)         Comparative Technology         Retail Price Technology         Onit Price         Quantity	Introductory State * Steady State *	20 15 20 Existing Technology Engineer's 15	20 40 50 Estimate based on bid prices 40	20 35 40 for New England 35	10 8 10 170 Type Controller 8	20 1 1.5		20 10 15 Existing Technology 10					Introductory State * Steady State *		0.75 1 0.75	2 2.5	0.7 0.8 0.7	0.4 0.5 0.4	0.02 0.03 0.02	0.2 0.3 0.2			
Table 4-7. Unit Price W	Equipment Description		Train Detector Circuitry	(Cates for a 2-Quandrant Gate**	Bignals for a 2-Quandrant Gate**	nis		al le	ក្នុង pix Pedestrian Warning Signal and Gates		1 ju	Communication Line from RS to TMS is included in TMS	Note: Software is off-the-shelf technology and unit price does		Maintenance for Equipment	Train Detector Circuitry @ 5% of Capital Cost	ভ   Gates for a 2-Quandrant Gate @ 5% of Capital Cost**	Signals for a 2-Quandrant Gate @ 2% of Capital Cost**	Intelligent Interface Controller (IIC	Communications Line from IIC to (WIE) @ 2% of Capital Cost	Pedestrian Warning Signal @ 2% of Capital Cost	** Note: 2-Quadrant Gates/Signals not included in currently active HRIs	D)	

Table 4-8. Unit Price Worksheet Advanced Rail Crossing (RS16)

20   15   20   Exiting lechnology Engineers	Equipment Description	ye Repli (Life	Prio (Lov	Unit Price (High)	t Unit Quantity Quantity Price (Low) (High)  Introductory State *		Retail Price *	Unit Price Quar	Quantity
10   50   55   for New England   10   8   10   170 Type Controller   10   20   1   1.5   Existing Technology   10   15   Existing Technology   10   25   30	Irain Detector Circuitry Gates for a 4-Quandrant Gate	20	15	20		Existing 1 echnologing Estimate based or	ly Engineer's n bid prices	15	
10	Signals for a 4-Quandrant Gate	20	20	22		for New Eng	gland	20	
1.5   20   1   1.5   Existing Technology   20   10   15   Existing Technology   25   30   Existing Technology   25   25   25   25   25   25   25   2	Intelligent Interface Controller (IIC)	10	8	10		170 Type Controlle	Je.	8	
20	Communications Line from IIC to Wayside Int Equip (WIE)		-	1.5				-	
20	Assume two track xing w/ two 0.5 mile comm lines								
10   25   30   Existing Technology   "Mobilizer", Autoscope or sim.   who belizer in the control of the contr	Pedestrian Warning Signal and Gates	20	10	15		Existing Technolo	ogy	10	
loes  Introductory State *  O.75 1  O.75 1  O.4 0.5  Cost  O.02 0.03  O.2 0.3  O.2 0.3  O.2 0.3  O.3 0.3  O.4 0.5  O.5 0.3  O.7 0	Entrapped Vehicle Detection Camera, w/ poles & controller		25	30		Existing Technolo	ogy	25	
Oesa						"Mobilizer", Autoso	cope or sim.		
Introductory State *						vision based wide	area tracking		
Introductory State *	Communication Line from RS to TMS is included in TMS								
Introductory State *   Introductory State *	Note: Software is off-the-shelf technology and unit price does	does							
Introductory State *	not reflect product development.								
Cost 0.75 1			Int	roducto	ory State *			Steady S	tate *
Cost 0.75 1	Maintenance for Equipment								
3.25 3.75 1 1.1 0.4 0.5 Cost 0.02 0.03 0.2 0.3 1.25 1.5	Train Detector Circuitry @ 5% of Capital Cost		0.75	1				0.75	
Cost 0.02 0.03	Gates for a 4-Quandrant Gate @ 5% of Capital Cost		3.25	3.75				3.25	
Cost 0.02 0.03	Signals for a 4-Quandrant Gate @ 2% of Capital Cost		1	1.1				1	
0.02     0.03       0.2     0.3       1.25     1.5	Intelligent Interface Controller (IIC) @ 5 % of Capital Cost	Sost	9.0	0.5				0.4	
0.3	Communications Line from IIC to (WIE) @ 2% of Capital Cost	tal Cost	0.02	0.03				0.02	
1.5	Pedestrian Warning Signal @ 2% of Capital Cost		0.2	0.3				0.2	
	Entrapped Vehicle Detection @ 5% of Capital Cost		1.25	1.5				1.25	

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Table 4-9. Unit Price Worksheet Roadway In-Vehicle Signing for HRI (RS7a)

Quantity	state *										state *										5 dollars.
Unit Price	Steady State *	8	8								Steady State	6.0									sands of 199
Retail Price *		≣xist.	ces																		All prices are in thousands of 1995 dollars.
Comparative Technology		Ref. Seimens Exist.	Technology Prices									Exist. Tech.									* All p
Quantity (High)	* •										*										
Quantity (Low)	Introductory State *										Introductory State										
Unit Price (High)	troduc	2	8								troduc	0.5									
Unit Price (Low)	'n	3	3								ī	6.0									
Years to Replacement (Life Cycle)		2	10																		
Equipment Description		Signal Transmitter (2 Beacons per intersection)	Localized Controller									Beacon Maintenance (10% of Capital Cost)		Communication from TMC to Beacons is included in TMC Costs							
		<u> </u>	_	Jəu			lon Ca	ţiu	I)				(əɔ	บยเ		s g	ije.	ıəd	0)		

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Table 4-10. Unit Price Worksheet Roadway Traffic Information Dissemination for HRI (RS14a)

Replication   Price   Class   Class	
Introductory State *   Existing Technology, Reference	Equipment Description
10   15   Existing Technology, Reference	
ntroductory State *  0.75 Estimate	CMS three line, with 12 inch letters, precanned messages
ntroductory State *  0.75 Estimate	
0.75 Estimate	
0.75 Estimate	
0.75 Estimate	
	CMS (5% of capital)
	Leased Line Costs borne by TMCs

# 5. SAMPLE EXPENDITURE CALCULATIONS - MAJOR URBAN AREA

The Highway-Rail Interface addendum to the Phase 2 Cost Analysis of the National ITS Architecture includes an evaluation of three separate scenarios. Each scenario represents a typical deployment area and is to provide a frame of reference for similar implementations of the architecture. A high level description of the major urban area, Urbansville, is included in the original Evaluatory Design Document. A more indepth description of Urbansville is located in the "Urban Scenario Guide, Urbansville, Phase II" scenario description document. This HRI Cost Analysis addendum utilizes the existing Urbansville description and augments it with HRI specific descriptions. These descriptions are provided in the beginning sections of this document.

The cost analysis time frame evaluates deployment milestones as specified in the Phase II Deliverable Guidelines at the five, ten and twenty year stages in the deployment. Technology selection and developmental insights are based on these milestones equating to the calendar years 1997, 2002, and 2012, respectively.

#### 5.1 Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the previous sections 4.6.1 through 4.6.2. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and maintenance requirements. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology (often referenced to equipment manufacturers' estimated unit prices for comparable technology) and developing technology (also using comparable technology and referenced to integration and systems engineering companies' and equipment manufacturers' estimated unit prices for comparable technology.)

The unit price justification is noted in the worksheets' column for "Comparative Technology." In the worksheets, where "Existing Technology" is noted, the prices represent typical unit prices for equipment found in catalogs, such as Sweet's Engineering and Retrofit, a catalog for construction cost estimating for current, off-the-shelf technology. Other references to price justification indicate specific construction bid prices for recent contracts. These prices are actual bid prices for installation. Where these two forms of justification were not available, some estimations are provided through consultations with experts in respective fields for manufacturing, and system integration. Lastly, some prices which are less certain are estimates based on professional judgment.

#### 5.2 Identification and Evaluation of Quantities and Market Size

For the Equipment Package parameters, the quantity of items purchased influences the unit price for the equipment. Obviously, price breaks come into effect when larger quantities are purchased. For existing technology, many equipment prices are at a steady state price (exhibited in the far right columns of the Equipment Worksheets.) The prices are generally not subject to wide fluctuations based on quantities. Newer technology, or services which are on the front end of a market/product development curve, are subject to wide price ranges. For Urbansville, two sets of market penetrations were analyzed, a high and a low scenario. For the cost evaluation activities the low value of the unit price ranges was utilized for all Equipment Packages.

#### **5.3** Calculation of Expenditures

Expenditures are calculated automatically through the linked spreadsheet programs. Included in the calculation are non-recurring expenditures (one time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred in accordance with the Evaluatory Design Document deployment quantities for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the expenditures for asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets. This tabulation of non-recurring expenditures continues from the year of initial deployment through the analysis time frame. This evaluation is important when considering comparative technologies and life cycle costs (see previous section on life cycle costing.)

#### 5.4 Results

The summary expenditures for the Urbansville HRI Equipment Packages are provided in the following pages. The non-recurring expenditures are tabulated below for the deployment milestone in the evaluation period. Note that the summations consists of the expenditures for the year stated plus the expenditures for the four previous years. The numbers presented for the recurring expenditures represent the expenditures for operation and maintenance during the deployment milestone years. Note that the non-recurring expenditures include replacement expenditures for reinvestment of equipment at the end of its' useful life.

The first of the analysis results, are for a low level market penetration, consistent with the evaluatory design parameters for deployment penetration. The second set of results are for the high level market penetration. For each of the scenarios, it was assumed that the HRIs that are already equipped with active gates/signals would not require that equipment. Thus, for Urbansville, the expenditure for the gates and signals for the HRIs in RS15a were not included in the full expenditure calculated from the unit price worksheets. RS15b includes the cost of the gates/signals for a 2-quadrant system.

All expenditures for Urbansville are in 1,000s of dollars based on 1995 prices.

Table 5-1. Urbansville Non-Recurring Expenditures for Low Market Penetration

		Non-Recurring Expenditures		
EP ID	Equipment Package Name	1-5 yrs	6-10 yrs	11-20 yrs
TMS18	HRI Traffic Management	\$0	\$108	\$252
TMS19	Rail Operations Coordination	\$0	\$109	\$253
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$2,856	\$3,528
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$1,744	\$1,981
RS16	Advanced Rail Crossing	\$0	\$2,958	\$3,094
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$330	\$765
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$880	\$720

**Table 5-2.** Urbansville Recurring Expenditures for Low Market Penetration

		Average Annual Recurring Expenditures		
EP ID	Equipment Package Name	Year 5	Year 10	Year 20
TMS18	HRI Traffic Management	\$0	\$47	\$140
TMS19	Rail Operations Coordination	\$0	\$47	\$142
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$115	\$230
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$65	\$134
RS16	Advanced Rail Crossing	\$0	\$117	\$234
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$17	\$30
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$44	\$80

Table 5-3. Urbansville Non-Recurring Expenditures for High Market Penetration

		Non-Recurring Expenditures			
EP ID	Equipment Package Name	1-5 yrs	6-10 yrs	11-20 yrs	
TMS18	HRI Traffic Management	\$0	\$216	\$396	
TMS19	Rail Operations Coordination	\$0	\$217	\$398	
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$6,256	\$4,736	
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$3,924	\$2,359	
RS16	Advanced Rail Crossing	\$0	\$6,786	\$3,270	
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$660	\$1,332	
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$1,760	\$910	

Table 5-4. Urbansville Recurring Expenditures for High Market Penetration

		Average Annual Recurring Expenditures		
EP ID	Equipment Package Name	Year 5	Year 10	Year 20
TMS18	Rail Operations Coordination	\$0	\$95	\$237
TMS19	HRI Traffic Management	\$0	\$94	\$234
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$115	\$230
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$65	\$134
RS16	Advanced Rail Crossing	\$0	\$117	\$234
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$33	\$50
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$88	\$134

#### 6. SAMPLE EXPENDITURE CALCULATIONS - INTER-URBAN AREA

A high level description of the inter-urban area, Thruville, is included in the original Evaluatory Design Document. A more in-depth description of Thruville is located in the "Inter-urban Scenario Guide, Thruville, Phase II" scenario description document. Similar to the Urbansville sample expenditures, this HRI Cost Analysis addendum utilizes the existing Thruville description and augments it with HRI specific descriptions. These descriptions are provided in the beginning sections of this document.

The cost analysis time frame evaluates deployment milestones as specified in the Phase II Deliverable Guidelines at the five, ten and twenty year stages in the deployment. Technology selection and developmental insights are based on these milestones equating to the calendar years 1997, 2002, and 2012, respectively.

# 6.1 Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the previous sections 4.6.1 through 4.6.2. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and maintenance requirements. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology (often referenced to equipment manufacturers' estimated unit prices for comparable technology) and developing technology (also using comparable technology and referenced to integration and systems engineering companies' and equipment manufacturers' estimated unit prices for comparable technology.)

The unit price justification is noted in the worksheets' column for "Comparative Technology." In the worksheets, where "Existing Technology" is noted, the prices represent typical unit prices for equipment found in catalogs, such as Sweet's Engineering and Retrofit, a catalog for construction cost estimating for current, off-the-shelf technology. Other references to price justification indicate specific construction bid prices for recent contracts. These prices are actual bid prices for installation. Where these two forms of justification were not available, some estimations are provided through consultations with experts in respective fields for manufacturing, and system integration. Lastly, some prices which are less certain are estimates based on professional judgment.

# 6.2 Identification and Evaluation of Quantities and Market Size

For the Equipment Package parameters, the quantity of items purchased influences the unit price for the equipment. Obviously, price breaks come into effect when larger quantities are purchased. For existing technology, many equipment prices are at a steady state price (exhibited in the far right columns of the Equipment Worksheets.) The prices are generally not subject to wide fluctuations based on quantities. Newer technology, or services which are on the front end of a market/product development curve, are subject to wide price ranges.

Similar to Urbansville, for Thruville, two sets of market penetrations were analyzed, a high and a low scenario. For the cost evaluation activities the low value of the unit price ranges was utilized for all Equipment Packages.

#### **6.3** Calculation of Expenditures

Expenditures are calculated automatically through the linked spreadsheet programs. Included in the calculation are non-recurring expenditures (one time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred in accordance with the Evaluatory Design Document deployment quantities for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the expenditures for asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets. This tabulation of non-recurring expenditures continues from the year of initial deployment through the analysis time frame. This evaluation is important when considering comparative technologies and life cycle costs (see previous section on life cycle costing.)

#### 6.4 Results

The summary expenditures for the Thruville HRI Equipment Packages are provided in the following pages. The non-recurring expenditures are tabulated below for the deployment milestone in the evaluation period. Note that the summations consists of the expenditures for the year stated plus the expenditures for the four previous years. The numbers presented for the recurring expenditures represent the expenditures for operation and maintenance during the deployment milestone years. Note that the non-recurring expenditures include replacement expenditures for reinvestment of equipment at the end of its' useful life.

The first of the analysis results, are for a low level market penetration, consistent with the evaluatory design parameters for deployment penetration. The second set of results are for the high level market penetration. For each of the scenarios, it was assumed that the HRIs that are already equipped with active gates/signals would not require that equipment. Thus, for Thruville, the expenditure for the gates and signals for the HRIs in RS15a were not included in the full expenditure calculated from the unit price worksheets. RS15b includes the cost of the gates/signals for a 2-quadrant system.

All expenditures for Thruville are in 1,000s of dollars based on 1995 prices.

Table 6-1. Thruville Non-Recurring Expenditures for Low Market Penetration

		Non-Recurring Expenditures		
EP ID	Equipment Package Name	1-5 yrs	6-10 yrs	11-20 yrs
TMS18	HRI Traffic Management	\$0	\$0	\$108
TMS19	Rail Operations Coordination	\$0	\$0	\$109
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$1,190	\$1,436
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$981	\$1,053
RS16	Advanced Rail Crossing	\$0	\$1,218	\$1,274
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$132	\$330
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$350	\$350

Table 6-2. Thruville Recurring Expenditures for Low Market Penetration

		Average Annual Recurring Expenditures		
EP ID	Equipment Package Name	Year 5	Year 10	Year 20
TMS18	HRI Traffic Management	\$0	\$0	\$47
TMS19	Rail Operations Coordination	\$0	\$0	\$47
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$48	\$95
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$37	\$73
RS16	Advanced Rail Crossing	\$0	\$48	\$96
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$7	\$13
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$18	\$35

Table 6-3. Thruville Non-Recurring Expenditures for High Market Penetration

	Table 0-3. Thi uvine Non-Recuiring Expenditures for ringh what ket I enetration			
		Non-Recurring Expenditures		
EP ID	Equipment Package Name	1-5 yrs	6-10 yrs	11-20 yrs
TMS18	HRI Traffic Management	\$0	\$108	\$144
TMS19	Rail Operations Coordination	\$0	\$109	\$145
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$2,346	\$2,116
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$1,962	\$1,452
RS16	Advanced Rail Crossing	\$0	\$2,436	\$1,678
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$264	\$570
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$700	\$460

Table 6-4. Thruville Recurring Expenditures for High Market Penetration

		Average Annual Recurring Expenditures		
EP ID	Equipment Package Name	Year 5	Year 10	Year 20
TMS18	HRI Traffic Management	\$0	\$47	\$94
TMS19	Rail Operations Coordination	\$0	\$47	\$95
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$95	\$158
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$73	\$122
RS16	Advanced Rail Crossing	\$0	\$96	\$158
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$13	\$22
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$35	\$58

#### 7. SAMPLE EXPENDITURE CALCULATIONS - RURAL AREA

A high level description of the rural area, Mountainville, is included in the original Evaluatory Design Document. A more in-depth description of Mountainville is located in the "Rural Scenario Guide, Mountainville, Phase II" scenario description document. Similar to the Urbansville sample expenditures, this HRI Cost Analysis addendum utilizes the existing Mountainville description and augments it with HRI specific descriptions. These descriptions are provided in the beginning sections of this document.

The cost analysis time frame evaluates deployment milestones as specified in the Phase II Deliverable Guidelines at the five, ten and twenty year stages in the deployment. Technology selection and developmental insights are based on these milestones equating to the calendar years 1997, 2002, and 2012, respectively.

# 7.1 Examination of Equipment Package Worksheets

Equipment Package Worksheets are included in the previous sections 4.6.1 through 4.6.2. Each worksheet lists equipment and price ranges for that equipment, including hardware and software, as well as operation (additional staffing) and maintenance requirements. The price ranges represent state-of-the-practice equipment using installed construction bid prices for some packages, state-of-the-art equipment using comparable technology (often referenced to equipment manufacturers' estimated unit prices for comparable technology) and developing technology (also using comparable technology and referenced to integration and systems engineering companies' and equipment manufacturers' estimated unit prices for comparable technology.)

The unit price justification is noted in the worksheets' column for "Comparative Technology." In the worksheets, where "Existing Technology" is noted, the prices represent typical unit prices for equipment found in catalogs, such as Sweet's Engineering and Retrofit, a catalog for construction cost estimating for current, off-the-shelf technology. Other references to price justification indicate specific construction bid prices for recent contracts. These prices are actual bid prices for installation. Where these two forms of justification were not available, some estimations are provided through consultations with experts in respective fields for manufacturing, and system integration. Lastly, some prices which are less certain are estimates based on professional judgment.

# 7.2 Identification and Evaluation of Quantities and Market Size

For the Equipment Package parameters, the quantity of items purchased influences the unit price for the equipment. Obviously, price breaks come into effect when larger quantities are purchased. For existing technology, many equipment prices are at a steady state price (exhibited in the far right columns of the Equipment Worksheets.) The prices are generally not subject to wide fluctuations based on quantities. Newer technology, or services which are on the front end of a market/product development curve, are subject to wide price ranges.

Similar to Urbansville, for Mountainville, two sets of market penetrations were analyzed, a high and a low scenario. For the cost evaluation activities the low value of the unit price ranges was utilized for all Equipment Packages.

#### 7.3 Calculation of Expenditures

Expenditures are calculated automatically through the linked spreadsheet programs. Included in the calculation are non-recurring expenditures (one time capital costs) and recurring expenditures (annual operation and maintenance costs). The non-recurring expenditures are incurred in accordance with the Evaluatory Design Document deployment quantities for the five, ten and twenty deployment years. The recurring expenditures are incurred in the deployment year and every year thereafter.

Non-recurring expenditures also include the expenditures for asset replacement at the end of its useful life. These expenditures are automatically incorporated into the spreadsheet utilizing the "Years to Replacement" column in the Equipment Package Worksheets. This tabulation of non-recurring expenditures continues from the year of initial deployment through the analysis time frame. This evaluation is important when considering comparative technologies and life cycle costs (see previous section on life cycle costing.)

#### 7.4 Results

The summary expenditures for the Mountainville HRI Equipment Packages are provided in the following pages. The non-recurring expenditures are tabulated below for the deployment milestone in the evaluation period. Note that the summations consists of the expenditures for the year stated plus the expenditures for the four previous years. The numbers presented for the recurring expenditures represent the expenditures for operation and maintenance during the deployment milestone years. Note that the non-recurring expenditures include replacement expenditures for reinvestment of equipment at the end of its' useful life.

The first of the analysis results, are for a low level market penetration, consistent with the evaluatory design parameters for deployment penetration. The second set of results are for the high level market penetration. For each of the scenarios, it was assumed that the HRIs that are already equipped with active gates/signals would not require that equipment. Thus, for Mountainville, the expenditure for the gates and signals for the HRIs in RS15a were not included in the full expenditure calculated from the unit price worksheets. RS15b includes the cost of the gates/signals for a 2-quadrant system.

All expenditures for Mountainville are in 1,000s of dollars based on 1995 prices.

Table 7-1. Mountainville Non-Recurring Expenditures for Low Market Penetration

		Non-Recurring Expenditures		
EP ID	Equipment Package Name	1-5 yrs	6-10 yrs	11-20 yrs
TMS18	HRI Traffic Management	\$0	\$0	\$0
TMS19	Rail Operations Coordination	\$0	\$0	\$0
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$34	\$42
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$218	\$125
RS16	Advanced Rail Crossing	\$0	\$0	\$0
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$6	\$15
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$20	\$20

Table 7-2. Mountainville Recurring Expenditures for Low Market Penetration

		Average Annual Recurring Expenditures			
EP ID	Equipment Package Name	Year 5	Year 10	Year 20	
TMS18	HRI Traffic Management	\$0	\$0	\$0	
TMS19	Rail Operations Coordination	\$0	\$0	\$0	
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$1	\$3	
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$8	\$12	
RS16	Advanced Rail Crossing	\$0	\$0	\$0	
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$0	\$1	
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$1	\$2	

Table 7-3. Mountainville Non-Recurring Expenditures for High Market Penetration

	Table 7-3. Wountain vine Non-Recurring Expenditures for riigh warket I enetration			
		Non-Recurring Expenditures		
EP ID	Equipment Package Name	1-5 yrs	6-10 yrs	11-20 yrs
TMS18	Rail Operations Coordination	\$0	\$0	\$0
TMS19	HRI Traffic Management	\$0	\$0	\$0
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$68	\$50
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$327	\$242
RS16	Advanced Rail Crossing	\$0	\$0	\$174
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$12	\$30
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$40	\$20

Table 7-4. Mountainville Recurring Expenditures for High Market Penetration

		Average Annual Recurring Expenditures		
EP ID	Equipment Package Name	Year 5	Year 10	Year 20
TMS18	Rail Operations Coordination	\$0	\$0	\$0
TMS19	HRI Traffic Management	\$0	\$0	\$0
RS15 (a)	Standard Rail Crossing (Currently Active HRIs)	\$0	\$3	\$4
RS15 (b)	Standard Rail Crossing (Currently Passive HRIs)	\$0	\$12	\$20
RS16	Advanced Rail Crossing	\$0	\$0	\$7
RS7 (a)	Roadway In-Vehicle Signing for HRI	\$0	\$1	\$1
RS14 (a)	Roadway Traffic Information Dissemination for HRI	\$0	\$2	\$3